SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JANUARY 6, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EXECUTIVE PROCEEDINGS: REPORT OF THE GENERAL SECRETARY.

THE first meeting of the American Association for the Advancement of Science was held in the City of Philadelphia, September 20th, 1848. There were then 461 members of the Association, but we have no record of the number in attendance. The second Philadelphia meeting was held September 3, 1884. The Association then numbered 1,981 members and the attendance was 1,261, including 303 members of the British Association for the Advancement of Science and nine other foreign guests. The third Philadelphia meeting was held December 27 to 31, 1904. The total membership was nearly 4,000 and the registered attendance numbered 588 members and 104 members of affiliated societies, making a total registered attendance of 692 members. From 200 to 400 did not register, so that we may safely conclude that the total attendance was at least 890, and perhaps very much larger.* The present meeting is, therefore, the third largest in point

* We estimate the number of scientific men in attendance to have been in the neighborhood of 1,200. 240 members of the American Chemical Society were registered, but only 75 for the Chemical Section of the Association. There were nearly 100 members of the American Psychological and Philosophical Associations in attendance, very few of whom registered. The conditions were probably similar in other sciences.—ED.

of numbers since the year 1884. While numbers are not an index of the value of a meeting, they do show the amount of interest taken in its proceedings, and from that standpoint we may conclude that the third Philadelphia meeting was a success. It was also a success from the standpoint of number of papers read and the general interest in the papers, as well as in all of the proceedings of the association.

Tabulating the members according to the sections for which they registered, we find the following numbers:

Section A	57
Section B	66
Section C	75
Section D	16
Section E	79
Section F	104
Section G	103
Section H	44
Section I	14
Section K	25

giving a total of 581 who signified their preference as to sections.

These figures show that where a national scientific society met in conjunction with the association, the corresponding section was large and where a national scientific society did not meet, the attendance was very small. This would seem to indicate that members of the association prefer to attend a meeting of the national society rather than the meetings of the association unless the two meet together.

The University of Pennsylvania placed its halls and laboratories freely at the disposal of the association and each day furnished a lunch to the members. The association has never received more careful attention than it received at this meeting. A vote of thanks was extended to the university, the details of which will be found later on in the report.

In former years a daily program has been published, showing the papers to be read that day and giving a list of the members in attendance. This has always been a severe drain upon the resources of the association and it was decided this year to use but one program, which was distributed to members on the first day papers were read. This single program seemed to answer its purpose as well as the daily programs have in the past, except that many members missed the lists of those in attendance. If some method can be devised by which members may know who are present, there can be no objection to the single program.

Since the last meeting of the association 377 members have been elected; although this is not as large as the number elected in previous years, yet it shows a steady growth and a growing interest on the part of the public in the work of the association.

There has always been great difficulty in getting reports of the association and its work published in the daily papers, except those in the city where the meeting is held. This year the Committee on Policy of the Association instructed the permanent secretary to appoint a press secretary. The permanent secretary appointed Mr. Theodore Waters. Reports of the meetings were prepared each day and sent to most of the prominent newspapers of the country. It was impossible to make the reports as full as desired, as some of the members of the association who read papers did not give their abstracts to the press secretary, although they were requested to do so. If the readers of papers will take pains to see that their abstracts are in the hands of the press secretary, entirely satisfactory reports can be sent out in future. It is greatly to be desired that the press of the country give some attention to the meetings of our greatest scientific society.

The two questions of general interest were the time of meetings of the association and our relation to the affiliated so-

cieties. These questions have been actively discussed before, but they do not seem to be definitely settled in the minds of many. The sections which have been in the habit of giving excursions and those who study objects out of doors, prefer a summer meeting, but it seems that a large majority of the association is in favor of the winter meetings, as the general committee unanimously decided to hold the next meeting during the winter. The committee on policy reported that it had considered this matter and would recommend that this general committee request the next general committee to hold a summer meeting in Ithaca during the summer of 1906. The success of this meeting will undoubtedly have a great deal to do with settling the question of summer meetings.

There seems to be no objection on the part of the association to holding two meetings each year, one during the winter and one during the summer. The expense involved would be considerable, but the association can bear it and perhaps the best solution of the problem will be two meetings. This is a question which the future must decide.

AFFILIATED SOCIETIES.

The following Affiliated Societies held sessions in conjunction with the association:

American Alpine Club.
The American Anthropological Association.
The American Chemical Society.
The American Folk-Lore Society.
The American Geographers' Association.
The American Mycological Society.
The American Philosophical Association.
The American Physical Society.
The American Psychological Association.
The American Physiological Society.
The American Society of Naturalists.
American Society of Vertebrate Paleontologists.
Association of American Anatomists.
The Association of Economic Entomologists.
The Astronomical and Astrophysical Society of America.
The Botanical Club of the Association.
The Botanical Society of America.
The Society for Plant Morphology and Physiology.
The Society for the Promotion of Agricultural Science.
Sullivant Moss Chapter.
The Wild Flower Preservation Society of America.
The Entomological Club of the Association.
Eastern Branch of American Society of Zoologists.
The Fern Chapter.
The Geological Society of America.
The Sigma XI Honorary Scientific Society.
The Society of American Bacteriologists.
The Society for Horticultural Science.
The Southern Society for Philosophy and Psychology.
The Pelee Club.

The association is still pursuing the policy of encouraging the great national societies to meet at the same time and place with it. The association secures rooms, provides accommodations, makes arrangements with hotels and railways and in all points takes charge of general arrangements without expense and without trouble to the affiliated societies.

Nearly, if not all, of the societies meet in perfect harmony with the respective sections. In almost every case the sections have charge of the general session in one half of the day and the affiliated societies have charge of the meetings during the other half of the day. Thus there is no friction and papers are presented before both bodies, while there is the additional advantage of a larger attendance at both the section and the society. It is hoped that this arrangement will appeal still more to the national societies until all of them enter into this arrangement with the association.

The attendance of the members of the societies this year indicates that they are willing to cordially cooperate with the association and turn out in large numbers to attend these joint meetings. There is

nothing in the arrangement which prevents an affiliated society holding a separate meeting at any other time of the year if it chooses.

The first session of the fifty-fourth meeting of the American Association for the Advancement of Science was called to order in College Hall Chapel, University of Pennsylvania, Philadelphia, Pa., at 10 A.M., Wednesday, December 28, 1904, by the retiring president, Dr. Carroll D. Wright. Dr. Wright introduced the president-elect, Dr. William G. Farlow, who made a brief address. Provost Harrison, of the University of Pennsylvania followed with an address of welcome.

President Farlow thanked Provost Harrison for his words of welcome and then asked the general secretary to make the announcements from the council.

Mr. Howe (general secretary): The Council has voted to extend the privileges of associate membership for this meeting to members of the local committee, residents of Philadelphia and vicinity and to members of the affiliated societies.

The following committees have been appointed to serve during this meeting:

Committee on New Members: The permanent secretary and the secretary of the Council.

Committee on Fellows: The general secretary and the vice-presidents of the sections, Mr. Howe, chairman.

Committee on Grants: The treasurer and the vice-presidents of the sections, Mr. R. S. Woodward, chairman.

It has been decided to hold sessions of the Council at nine o'clock in the morning, but there will be no other general session until Saturday morning at ten o'clock.

Dr. Calvert, secretary of the local committee, made some announcements in behalf of that committee in regard to the arrangements which had been made for the comfort and convenience of the association.

After the adjournment of the general session the several sections were organized in their respective rooms.

In accordance with a suggestion from the committee on the policy of the association, the vice-presidential addresses were scattered throughout the week, instead of being given on the same date.

It was thought best to have in addition to a vice-presidential address, one or more papers of general interest, which would follow the address, thus taking up the greater part of that session.

The general program of the week was as follows:

GENERAL EVENTS.

The council of the association met daily from December 28 to December 31, inclusive, at 9 A. M., in the auditorium, Houston Hall.

WEDNESDAY, DECEMBER 28, 1904.

Meeting of the council at 9 A. M., as above.

First general session of the association at 10 A. M., in the chapel, College Hall.

The meeting was called to order by the retiring president, Dr. Carroll D. Wright, who introduced the president-elect, Dr. W. G. Farlow.

Addresses of welcome were delivered by members of the local committee.

President Farlow replied.

Announcements by the general, permanent and local secretaries.

Agreement on the hours of meeting.

Adjournment of the general session, followed by the organization of the sections in their respective halls.

At 1:00 P. M.

Luncheon to the members of the association and societies in the gymnasium.

At 2:30 P. M.

Addresses of vice-presidents as follows:

Vice-President Tittmann, before the Section of Mathematics and Astronomy, in College Hall. Subject, 'The Present State of Geodesy.'

Vice-President Bancroft, before the Section of Chemistry, in the Harrison Laboratory of Chemistry. Subject, 'Future Developments in Physical Chemistry.'

Vice-President Russell, before the Section of Geology and Geography, in Geological Laboratory, College Hall. Subject, 'Cooperation among American Geographical Societies.'

At 8:00 P. M.

Address by Dr. Carroll D. Wright, the retiring President of the Association, in the gymnasium. Subject, 'Science and Economics.'

At 9:00 P. M.

Reception by the Provost of the University of Pennsylvania, Dr. C. C. Harrison and Mrs. Harrison, in the Museum.

THURSDAY, DECEMBER 29, 1904.

Meeting of the council at 9 A. M.

Meetings of the sections at 10 A. M.

At 1:00 P. M.

Luncheon to the members of the association and societies in the gymnasium.

At 2:30 P. M.

Addresses of vice-presidents as follows:

Vice-President Hall, before the Section of Physics, in Morgan Laboratory of Physics. Subject, 'A Tentative Theory of Thermo-Electric Actions.'

Vice-President MacBride, before the Section of Botany, in Biological Hall. Subject, 'The Alamogordo Desert.'

Vice-President Mark, before the Section of Zoology, in Laboratory of Physiology and Pathology. Subject, 'The Bermuda Islands and the Bermuda Biological Station for Research.'

Vice-President Baldwin, before the Section of Social and Economic Science, in Logan Hall. Subject, 'The Modern Droit d'Aubaine.'

At 8:00 P. M.

The retiring President of the American Chemical Society, Dr. Arthur A. Noyes, delivered a lecture, illustrated by experiments, on the 'Preparation and Properties of Colloidal Solutions,' in the Harrison Laboratory of Chemistry.

FRIDAY, DECEMBER 30, 1904.

Meetings of the council at 9 A. M.

Meetings of the sections at 10 A. M.

At 1:00 P. M.

Luncheon to the members of the association and societies in the gymnasium.

At 2:30 P. M.

Addresses of vice-presidents as follows:

Vice-President Woodward, before the Section of Mechanical Science and Engineering, in the Mechanical Laboratory. Subject, 'Recent Progress in Engineering Education.'

Vice-President Saville, before the Section of Anthropology, in the Museum of Science and Art. Subject, 'Mexican and Central American Archeology.'

At 10:00 P. M.

Meeting of the General Committee at the Hotel Walton.

SATURDAY, DECEMBER 31, 1904.

Meeting of the council at 9 A. M.

Final general session at 10 A. M., in the chapel, College Hall.

Meeting of the sections following the adjournment of the general session.

At 1 P. M.

Luncheon to the members of the association and societies in the gymnasium.

EXCURSIONS.

Excursions to the following plants were arranged by the local committee:

Belmont Filtration Plant (filtration of city water).

F. A. Poth & Sons Brewery.

J. P. Baltz Brewing Company.

Eddystone Print Works, Eddystone, Pa. (bleaching and dyeing of all kinds of cotton goods, engraving and preparing the rolls).

Barrett Manufacturing Coo. (refined coal-tar chemicals).

Baldwin Locomotive Works.

Atlantic Refining Co. (petroleum oils).

Cramp's Ship Yard.

Camden Coke Company (Otto-Hoffman by-product coke ovens).

United Gas Improvement Co. (coal and water gas).

Hulton Brothers (dyeing and finishing).

Forth & Foster (dyeing and finishing).

United States Arsenal.

United States Mint.

United States Navy Yard.

Gillinder's Glass Works.

High Pressure Fire Service Plant, kindness of Mr. F. L. Hand, Chief of the Bureau of Water, Philadelphia.

Philadelphia Electric Co.'s new Power Station, through the kindness of Mr. J. B. McCall, President Phila. Electric Co.

Philadelphia Subway, through the kindness of Mr. W. S. Twining, chief engineer, and Mr. Charles M. Mills, principal assistant engineer, Subway and Elevated Railway Construction.

Wm. Sellers & Co., Inc., through the kindness of Mr. William Sellers and Mr. Coleman Sellers, Jr.

On Monday evening, December 26, 1904, the American Physiological Society held a smoker at the University Club.

On Tuesday evening, December 27, 1904, Professor W. F. Osborn gave a lecture before the American Society of Naturalists

in the Academy of Natural Sciences on the subject, 'Recent Discoveries of Extinct Animals in the Rocky Mountain Region and their Bearings on the Present Problems of Evolution.' On the same evening the American Society of Naturalists and the affiliated societies gave a smoker at the University Club.

Wednesday afternoon, December 28, 1904, was held the annual discussion of the American Society of Naturalists on the question 'Mutation Theory of Organic Evolution.' This was participated in by Dr. D. T. MacDougal, Professor W. E. Castle, Professor E. G. Conklin, Professor W. B. Scott, Professor T. Dwight, Professor L. H. Bailey and Dr. W. M. Wheeler. In the evening the annual dinner of the American Society of Naturalists was held.

On Thursday evening, December 29, the American Chemical Society held a commers at the University Club. The same evening the Psychological and Philosophical Association held a smoker. The same evening the Society of the Sigma Xi held a convention in College Hall.

Friday evening, December 30, the American Alpine Club held its annual dinner at the University Club.

The council elected as members of the council at large, J. McK. Cattell, J. M. Coulter and H. F. Osborn.

Professor C. R. Barnes, of the University of Chicago, Dr. H. C. Cowles, of the University of Chicago, and Mr. C. L. Shear, of the U. S. Department of Agriculture, were appointed as representatives to the International Botanical Congress to be held in Vienna in 1905. The reports of committees and the list of fellows elected will be printed in the next issue of SCIENCE.

AMENDMENTS.

The following amendment to the constitution which was proposed at the St. Louis meeting, favorably acted upon by the council and reported to the general session, was adopted:

Amend Article 34 by the omission of the words "On the election of any member as fellow, an additional fee of $2 shall be paid."

The proposed amendment of article 4, line 2, to read "The members of at least one year's standing, who are professionally engaged in science and have, by their labors, aided in advancing science" was unfavorably reported upon by the committee on policy.

POLICY OF THE ASSOCIATION.

The council appointed Mr. R. S. Woodward permanent chairman of the committee on policy of the association.

The council voted that the committee on policy of the association be requested to exercise a general executive control of the preliminary arrangements for meetings and of the publications, subject to the control of the council.

The committee on policy of the association reported the following resolutions which were adopted:

"That the permanent secretary be authorized to offer sets of the back volumes of the *Proceedings* to libraries, which shall be approved by the committee of the association appointed by the president."

"That the publishers of SCIENCE be requested to announce prominently that cut copies will be sent to members who request it."

"That the committee recommends as members, and if they become members, nominates as fellows, members of the national scientific societies not now members of the association in cases in which the national scientific society has a qualification for membership equal to that of the qualification of the association for fellowship. The following societies are accepted as having such qualifications:

The American Society of Naturalists.
The American Philosophical Society.
The American Academy of Arts and Sciences.
The Association of American Anatomists.
The Association of American Physicians.
The Association of Pathologists and Bacteriologists.
The Astronomical and Astrophysical Society of America.
The Botanical Society of America.
The Geological Society of America.
The American Mathematical Society.
Active members of the American Ornithological Union.
The American Philosophical Association.
The American Physical Society.
The American Physiological Society.
The American Psychological Association.
The American Society of Bacteriologists.
The Society of Plant Morphology and Physiology.
The American Zoological Society.

The following resolution was referred to the committee on policy of the association:

Resolved, that the year book of this association be hereafter sent bound to such members as may notify the permanent secretary of their desire to receive it in that form. Binding to be in cloth or boards, as the treasurer and secretary may think proper.

Dr. W. H. Hale introduced the following resolution, which was adopted:

Resolved, That the American Association for the Advancement of Science hereby extends its hearty congratulations and best wishes to Dr. Martin H. Boye, a founder of this association, and the only surviving founder of the parent association, that of American Geologists, afterwards called the American Association of Geologists and Naturalists, which was founded in this city in 1840, Dr. Boye being present at that time, as well as at the founding of the American Association for the Advancement of Science in 1848.

Professor C. M. Woodward introduced resolutions thanking the officers of the University of Pennsylvania and other institutions that had entertained the association and these were unanimously adopted.

At the meeting of the general committee, Friday evening, it was decided to hold the next meeting in New Orleans, the work of the association to begin Friday, December 29, 1905. Boston was recommended as the place of the meeting in 1906.

The following officers were elected for the New Orleans Meeting.

President—Professor C. M. Woodward, St. Louis, Mo.

Vice-Presidents:

Section A—Professor W. S. Eichelberger, Washington, D. C.
Section B—Professor Henry Crew, Evanston, Ill.
Section C—Professor Chas. F. Mabery, Cleveland, Ohio.
Section D—Professor F. W. McNair, Houghton, Mich.
Section E—Professor Wm. North Rice, Middletown, Conn.
Section F—Professor H. B. Ward, Lincoln, Neb.
Section G—Dr. Erwin F. Smith, Washington, D. C.
Section H—Dr. Geo. Grant McCurdy, New Haven, Conn.
Section I—Professor Irving Fischer, New Haven, Conn.
Section K—Professor Wm. T. Sedgwick, Boston, Mass.

Permanent Secretary—Dr. L. O. Howard was elected for a period of five years beginning August, 1905.

General Secretary—Professor C. A. Waldo, Lafayette, Ind.

Secretary of Council—Professor John F. Hayford, Washington, D. C.

Secretary Section K—Dr. Wm. J. Gies, New York City, N. Y.

CHARLES S. HOWE,
General Secretary.

---

*LINES OF PROGRESS IN ENGINEERING.**

THE engineering army, like the myriads of well-trained, well-equipped and well-organized soldiers of the Mikado, stretches from high ground to high ground along an extended front, facing the hosts of conservatism who are entrenched behind moats

* Address of the vice-president and chairman of Section D—Mechanical Science and Engineering, 1904.

of difficulties, redoubts of prejudices, batteries of tradition and in citadels of ignorance. Like the Japanese, the division commanders, looking well to their supplies of ammunition (*i. e.*, correct theories) and their daily rations (*i. e.*, materials of construction and shop practise), push forward now at one point and now at another, capturing hill after hill, now on the right, now on the left, and now in the center. The army of science never retreats; it forever forces back the frontiers of darkness, and solves problem after problem from the endless list of secrets with which the storehouses of nature are filled.

It is a glorious thing to belong to this engineering army, to rejoice in its triumphs and to share in its rewards. Its success is not accidental; its triumphs are not matters of chance. Engineering blood always tells. Just as we train our best soldiers and sailors at West Point and at Annapolis; and as our appliances at military and naval schools keep pace with the arts of war on land and sea; so our schools of engineering, if they are up-to-date institutions, keep pace in the theories they teach and in the laboratories they equip with the best engineering practise. Every advance at the front (to resume my simile) means an advance of all supplies and in the enlisting and training of recruits. I am by profession a recruiting officer, and I am engaged with my fellow officers in training and equipping men for the firing line and the front rank. That the new material we send forward may be just what is wanted, we must have information as to the progress making and the next points of attack. In short, our schools of engineering must know the lines of engineering progress.

I am well aware that I shall not be able to touch upon many of the important matters which my subject is sure to bring up, and I can not expect to take them in the order of their importance. Probably no two of us would agree upon their relative importance; one's environment has so much to do with what lies just beyond his horizon; so I doubt not you will supplement my statement with most interesting and valuable suggestions.

THE UTILIZATION OF WASTE ENERGY.

While much has been done and much more is doing at waterfalls and river rapids, large and small, the work of saving the energy which now runs to waste has but just begun. When the great waterfalls are utilized the rapids will remain. We are lost in wonder when we calculate the possibilities. Measure the volumes which rush over the 'Sault St. Marie,' as the waters of Lake Superior drop to the level of Lake Huron; and then again put your measuring rods into the vastly greater volumes which plunge and rush from Lake Erie to Lake Ontario; and still again through the rapids of the St. Lawrence to the sea level. At every vantage ground, the work of utilization has begun and no man now living will see that work stop. Turn next to smaller streams and mountain torrents—what fields open up to the hydraulic and electric engineers! Mountain reservoirs will serve the triple purpose of preventing destructive floods, of saving the energy for useful work and of aiding irrigation. At every count the doors open wide for the best of engineering enterprise and the best of engineers, hydraulic, mechanic, electric, irrigation, and the echo of each department must be heard in the engineering lecture-room and laboratory. The electric transformer has made the transmission of energy possible from mountain slopes to far cities, and has unlocked bewildering amounts of energy at thousands of points deemed hitherto inaccessible. No one can see far into the future, but we all easily see the dawn of a new era of energy saving. The streets of this city may yet

be lighted by the energy which now runs to waste at Niagara. In St. Louis we look to the slopes and canyons of the Rockies for our supply of sweet, wholesome water—we may yet look to the same regions for the energy to drive our cars and run our mills.

COMBUSTION ENGINES.

The clumsy steam-engine, with its wasteful furnace, its huge boiler and chimney, is doomed. It has done great work in producing available energy and in wasting still more. It has played a most important part in modern civilization, and it deserves well at our hands, but nothing can stay the decree of progress. Sentence will soon be pronounced, but the day of execution has not been set. I never expect to see the day when steam power plants will cease to exist, but my children will see such a day.

Think for a moment of the present complicated, indirect method of procedure for converting the energy stored in coal into mechanical energy in a moving piston or a revolving shaft. Coal and air are fed into a furnace where combustion converts them into great volumes of a mixture of hot gases. The greater part of the heat and all the volume of these gases escape through the chimney; a small part of the heat only is drawn off by the steel shell and tubes of a boiler and transmitted to a body of water, which is thereby transformed into steam. The steady generation of steam against high pressure, added to its expansion as the pressure is reduced, enables it, when conducted to a cylinder, to drive a piston or revolve a shaft, thereby producing mechanical power. The clumsiness of the operation is equalled only by its wastefulness, which varies from 88 per cent. to 95 per cent.

The problem to-day is: What is the most direct and most economical road from coal to moving machinery? Engineers are attacking this problem on all sides, and attacking it successfully—gas-engines, and combustion-engines of various sorts bear witness. The future prime-mover will burn (not explode) its fuel in the working cylinder, and the piston will be driven, first by the products of combustion as their volume increases, and secondly by their expansion against a diminishing resistance. I predict great things of the Diesel motor. Originally it was designed to burn powdered coal mixed with hot compressed air; but crude petroleum was found to be preferable. So long as oil flows abundantly from wells, oil will generally be used, but powdered fuel, native or prepared, will doubtless prevail ultimately. The economy and directness of the combustion motor can not be excelled, and when a few years of study and experiment have been applied to the work of simplifying the mechanism (it was a century from James Watt to a triple-expansion Corliss), we may expect it to come into general use for all great central power stations.

The vitality of the steam-engine is due to-day to the mechanical perfection of its design. Its simplicity is marvelous. It is started and stopped with the greatest ease and it almost takes care of itself. The invention of the steam turbine has probably given to the furnace and steam-boiler another lease of life. The wonderful adaptability of the turbine for electric generators is something which was not anticipated.

Will not some one design and construct a combustion engine which shall consume continuously oil and compressed air, thus maintaining a high pressure in a gas chest and driving a turbine with the products of the combustion used expansively as is now done with steam? The proposition is an attractive one, both for the lecture room and for the engineering laboratory. It is sufficient now to call attention to its pos-

sibility, and to indicate a point for study and progress.

It will not be amiss for me to quote the figures given me by the engineer in charge of the Diesel engines which drove the generators for power and light in the 'Tyrolean Alps' at the late world's fair in St. Louis.

These engines, three in number, of 225 horse power each, were the observed of many observing engineers during the seven months of the fair. The assistant engineer in charge kept daily records of the work done, and fuel used, and kindly gave me a sample of his reports. The details are extremely interesting. The work was measured at the switchboard, no allowance being made for loss of energy in the engine, air pump and generator. The total work of the three engines between noon and midnight was 2,768.5 K.W.H. This is equivalent to 3,711 H.P.H.

Total fuel used (Indiana oil), 266 gals.
Fuel per 100 K.W. hours, 9.58 gals.
Fuel cost in car-tank lots, 3c. per gal.
Cost per 100 K.W.H., $0.287.
Cost of the day's fuel, $7.98 or 2.15 mills per H.P.H.

Thus one cent paid for the fuel for one horse power for four hours, forty minutes.

The three engines worked under about two thirds of a full load and used three gallons of lubricating oil during the day.

The above figures seem to me little less than remarkable.

While still wasteful, as nature measures energy, these engines are several times as efficient as the better styles of ordinary steam-engines. Doubtless they lack simplicity and the certainty of action which comes from experience and close study; but I can not help feeling that the road to the future 'prime mover' runs hard by the construction shops of an internal-combustion engine. Let students and professors take warning.

ARTIFICIAL CENTERS OF POWER.

One of the most important openings for future engineering enterprises is the establishment of large power centers, not only where water power is available, but where fuel is abundant as well.

Take, for example, the vast coal mines in the vicinity of the city of Philadelphia and those in the vicinity of St. Louis. In each case the power for industrial establishments and all kinds of moving machinery, large and small, in use in the city, including the street cars and the rolling stock on all roads, can well be furnished by electrical currents from large generating establishments near the mines. Add to the above the establishment of gas works sufficiently large to furnish all the gas needed for illumination, for gas-engines, for heating and cooking purposes in a great city. In the case of St. Louis those gas works should be near the extensive coal mines of Belleville and other coal-producing regions only a few miles from the city.

The effect of these two great steps forward upon the physical and sociological characteristics of a city can hardly be overestimated. The ultimate economy and convenience of such installations are enough to justify them. We have yet to learn how cheaply fuel gas and electric currents can be furnished to large concentrated groups of consumers. But omitting all questions of mere financial economy, what a saving in health, beauty and enjoyment! The London fogs which we hear so much about are produced largely by London smoke, and the prevention of smoke will to a very great extent be the prevention of the fog. I look forward to the day when, instead of a small volcano of smoke from a brick crater above every house, St. Louis will have all its heating and cooking done by gas, and all power will be furnished by electric currents, or by gas and combustion-engines,

both gas and electricity coming from the gas works and power plants at the mouths of the coal mines in Illinois. What an era of cleanliness and comfort this presages! This era of cleanliness will be brought about by the engineers. Hence engineering education must see to it that engineering students are prepared for their high mission. The proposed 'Million Club' of St. Louis bears no comparison with a possible 'Clear Sky Club.' The former proposes to seduce 250,000 non-resident smokemakers into joining the 750,000 smokemakers already resident in St. Louis, thereby making smoke enough to shut out the sun entirely (they almost did it during a whole week last November). The 'Clear-Sky Club,' on the other hand, will propose to eliminate all smokers by sending coal-burning power plants to the mines, thereby leaving the city so clean and beautiful that 250,000 lovers of pure air, clear skies and godliness will seek homes among us of their own accord. The elimination of smoke, soot and ashes will make St. Louis absolutely bright and clean, and similar improvements here would go far towards producing the same beneficial results in the city of Philadelphia. Already our cities have, or are making arrangements for, an abundant supply of pure water. This has been and still is a great branch of engineering, and it deserves an important place in our schools of engineering. We must next provide pure air and a clear sky.

These steps forward involve no very great addition to our engineering knowledge, but they give opportunity for engineering enterprises, and they show most clearly how essential cooperation is in such work. Large power plants and extensive gas works require much private capital, unless we fly to the extreme of public ownership. The economic construction of large power plants and gas plants; the laying of pipe lines and an unprecedented amount of electric cables, all or nearly all underground, constitute a great field and furnish great engineering opportunity.

THE PURIFICATION OF RIVERS.

We have nearly reached the limit in river pollution. The public welfare will soon make an imperative demand for a halt. A great city like Chicago shall no longer load with poison a little stream like the Illinois, nor foully pollute a great river like the Mississippi. Let me frankly admit that even the city of St. Louis shall not forever dump and pour its refuse into the Mississippi River.

When the national government takes up the function of guarding every stream from pollution (and no state government can deal effectively with the problem) we shall have a great extension of the sphere of sanitary engineering. The recent discoveries by Dr. George T. Moore, of the Department of Agriculture, suggest the possibility of purifying a polluted stream so as to make it not only clear and sweet, but absolutely free from algæ and all harmful bacilli. The proper disposition of house drainage and the refuse of factories is already a live engineering problem in Europe, and American engineers must no longer neglect it. The study of diseases and their prevention is forcing its way into engineering schools, as preliminary to extensive engineering practise. Whatever form the solution of the problem may take, it will involve both chemical and hydraulic engineering, and the fundamental principles of both must be carefully laid in our schools.

TUBULAR CONSTRUCTIONS.

In the near future we are likely to make great progress in the construction of rolling stock and moving machinery, as well as in the construction of bridges and buildings.

The adoption of electricity by railroads for all kinds of traffic will result, in the first place, in the disappearance of the

heavy locomotive. So long as the locomotive was needed to pull a long train of cars, great weight was necessary, and the weight of railway engines and the strength of bridges have been increasing at a rapid rate. We saw a locomotive at the recent fair at St. Louis weighing over 200 tons. It was a monster, indeed. Should such locomotives become common, every bridge in the country would have to be rebuilt.

But when each car, whether for passengers or for freight, has its own motor and drives itself, the heavy locomotive is no longer needed. Moreover, the car itself should be made as light as possible consistent with strength. Weight is of no advantage to a self-driven car. The bicycle has taught us a great lesson in the art of construction. A maximum of strength and stiffness with a minimum of weight. This already prevails in girders and bridge constructions. The same principles should be applied to all rolling stock and moving machinery. Tubular axles, tubular spokes, tubular fellies, tubular shafts, tubular everything is to be the law of future construction. All the great steam-engines and propellers already have hollow shafts, and I predict an enormous increase in the amount and precision of hollow steel tubing manufactured and used in the next ten years. The mechanical and material advantage of tubular shafting is easily stated. Thus: (1) If a solid cylindrical shaft be compared with a hollow shaft of the same weight per foot of length, but whose exterior diameter is n times as great, the strength of the hollow shaft in torsion is $2n - 1/n$ times as great as that of the solid shaft. (2) If only equal strength is required, the solid shaft having one nth of the diameter of the tube, will weigh $2n - 1/n^2$ times as much. For a numerical example: (a) A thin tubular shaft four inches in diameter is seven and three fourth times as strong as a solid shaft one inch in diameter which weighs the same per linear foot.

(b) A solid shaft weighs seven and thirty-one thirty-seconds (call it eight) times as much as a tubular shaft of equal strength and four times its diameter.

The ratio of stiffness of the tube to that of the solid shaft is even greater.

At the recent St. Louis fair a prize of $2,500 was offered for the lightest motor per horse power. Motors up to 100 horse power were eligible. The prize was not awarded, for the reason that inventors and constructors of motors were not prepared to submit their apparatus to the rigid tests required for efficiency and durability; but the offer was made with distinct intention of stimulating the construction of motors which should be suitable for vehicles where lightness combined with great strength is a desideratum, such as in automobiles and air-ships.

STEEL AND CONCRETE AND CEMENT.

I scarcely need call your attention to the important part which steel-concrete constructions are destined to play in future structures. Originally all important bridges, walls and dams were built of stone, and masonry flourished as a fine art. Arches, groined and cloistered, segmental and gothic, elliptic and parabola, combined to make cathedrals and chapels beautiful, and bridges stately and strong as well as durable. Then came the era of iron and steel, and stone bridges were built no more. Steel trusses, posts and girders took the place of stone walls and granite arches. We are now going back to masonry walls and to masonry bridges, but the masonry is no longer granite; it is concrete reenforced by steel. Evidently the opening for engineering theory and engineering enterprise is most extensive. The new material is not subject to corrosion, so it will not be eaten up by rust. It is incombustible, and

is not easily melted or weakened by heat, and above all it is inexpensive and easily handled. The field is a great one, and both the theory and the practise of steel and concrete combinations enter, or should enter, into the curriculum of every student of civil engineering and architecture. In the Austrian building at the recent fair in St. Louis there was a model of the centering of an arch, evidently steel-concrete, of 80 meters span (262 feet). You will remember that the beautiful and imposing 'Cabin John Bridge,' built of granite, in Washington, D. C., the greatest stone arch in the United States, has a span of 220 feet.

The recent enormous increase in the manufacture of Portland cement is an indication of the coming demand. It has taken thousands, perhaps millions, of years in the laboratory of nature, to produce the masses of granite and the layers of marble and limestone; the engineer and the chemist, working together, produce from the abundant supplies of material near at hand an artificial masonry in a few hours. Of its strength and durability the engineering laboratory and a brief experience tell us much. The verdict of a thousand years is still to be rendered, but here again the hand of promise points our way.

AERIAL NAVIGATION.

Above I casually mentioned air ships. You must bear with me while I say several things about aerial navigation.

We have been accustomed to regard the problem of practically navigating the air as one which could not be solved, or, at any rate, as a sort of fad hardly deserving of mention in connection with engineering. It will be remembered that the late eminent engineer, Professor J. B. Johnson, would not admit that aerial navigation was a possibility. He classed it with the problem of perpetual motion. But a careful examination of all the conditions seems to me to point towards the possibility of progress, and all that we can at present claim for many desirable improvements is that they admit of progress. We can not with any confidence predict the rate of progress. Some of the things I have already pointed out bear directly upon the problem of aerial navigation; two in particular: The use of tubular constructions for the maximum of strength and the minimum of weight; and the construction of motors which are strong and light; but many problems must be solved before we can really navigate the air.

It was my privilege to be connected with the discussion of aerial matters at the late fair in St. Louis. Without my knowledge I was selected as the president of the aeronautic congress, in which the problems of aeronautics were carefully discussed. That congress had no functions whatever in regard to aerial exhibits, or attempts to exhibit air ships, at the world's fair. The latter feature of the fair I regret to say was a deplorable failure. The greater part of the failure was inevitable, since aerial experimentation is expensive and difficult, and it has very rarely been undertaken by scientific people. What has been anywhere in that direction has been for the most part crude, ill-advised and unscientific, and failures have generally attended any attempts to actually navigate the air. Of course there are exceptions in the character of the investigations made. I could mention four Americans who are approaching the problem carefully and on scientific lines. Some of their investigations and experiments are full of promise for the future of aerial navigation.

So far as the failure of the spectacular part of aeronautics at the fair was concerned, that failure was due very largely to the vandalism of some crazy crank or rival, who cruelly mutilated the air ship brought over by Santos Dumont at great expense, to be used during the summer in

St. Louis; and especially was the failure due to the most unfortunate and unwarranted charge which a police officer made in response to a call for a report in regard to the mutilation of 'Santos-Dumont No. 7.' Being unable to get any clue to the guilty wretch (who had plenty of time to slip in and slash the gathered silk in hundreds of places while the guard sipped his coffee in a booth a few hundred yards away), and feeling doubtless that he must give some explanation, he actually stated that in his opinion the injury was inflicted either by Santos-Dumont himself or by some one of his men. No more injurious, unwarranted or insensate charge could have been made, and no person who was in any way acquainted with Santos Dumont could have made it; and yet that charge became current in the newspapers and was half believed by a great many very respectable people far and wide. Doubtless the currency of that charge did much to discourage and repel Santos Dumont from our shores. That he should have received such treatment in America was surprising and greatly to be regretted. It went far to give us a bad reputation in European circles. We are credited with hostility towards European inventors and experimenters. I trust Mr. Santos Dumont may eventually learn that Americans as a rule are fair-minded, generous and friendly towards all experimenters in every field. I trust he may learn that not one, so far as I know, of the gentlemen who were associated with him during his two visits to St. Louis sympathizes in any way, or to any extent, with the insinuations thrown out against him by the officer above referred to.

From this digression I now turn to the subject in hand, namely, the possibility of progress in the art of aerial navigation. Regarding progress in aerial navigation as entirely possible, I notice that it depends upon the solution of many problems, and no successful air-ship can reasonably be expected to appear until these problems are solved.

There are two lines of attack, which, while differing in one respect, have very much in common. Investigators are naturally divided into two classes: One seeking to devise methods for navigating the air as birds do, which gain support and propulsion solely from mechanical and muscular energy; and the other relying for support, more or less, upon the buoyancy of hydrogen gas, while securing propulsion by means of propellers. All are clearly interested in motors, whether the air-ship moves with or without the support of a bag of hydrogen. All are concerned with methods of management, and with the adoption of means for directing the movements of an air ship through the air.

If a gas bag is to be used, it is evident that the shape of the bag which involves the least amount of resistance is of first importance, and if that bag is to be a diminishing quantity, the ship must secure support from the use of aeroplanes or curved surfaces as the craft is driven rapidly forward. It is evident that the character of supporting surfaces and their distribution are matters of first importance in all cases. The number of preliminary lemmas which must be solved before the main proposition is reached is readily seen. The recent aeronautical congress concerned itself wholly with discussions and reports of experiments upon these preliminary matters, and I can truthfully say that excellent work was done.

I spoke of the gas bag as being a diminishing quantity. I wish to add a few words to make my meaning clear. When it was first proposed to propel an ocean ship by means of mechanical power, it was assumed as a matter of course that the

ship itself could float upon the water, and that mechanism was to be employed solely for the purpose of driving it forward and for steering it. In aerial navigation the case is different. The ship is not only to be driven forward, but it must be supported. The analogous case, therefore, is not that of an ocean ship, but of a heavy swimmer who must both support and drive himself forward. Swimming does not come to boy or girl by nature, and the skillful teacher furnishes a temporary support while the learner masters the art of using his hands, feet and legs correctly. Accordingly, he applies either a buoyant bag of air between the boy's shoulders, or the gentle lift of a string attached to a pole, and thus supports the learner while he masters the mechanical details of swimming. This exterior lift or support is a diminishing quantity as the pupil progresses, and when correct motions are learned and become automatic, the pupil swims and external aid is no longer necessary.

Similarly, as it seems to me, aerial navigation is to be accomplished. At first the craft may very properly be supported by a bag of hydrogen. Something must hold the structure which is to carry motor, propellers, fuel, ballast, steering apparatus, aero-planes, etc., above the ground, in comparatively still air, while tests can be made and skill in management can be acquired. Infinite patience, plenty of money and first-class engineering culture and skill will be required. The various elements must be studied one at a time, while a friendly gas bag holds the experimenter aloft. When an engineer can build a durable and well-portioned motor and system of propellers, which shall be as strong as twenty horses and only as heavy as twenty geese; and when he can drive his supporting bag of hydrogen through the air at the rate of twenty or thirty miles per hour, he can reduce the size of his bag and get support from aeroplanes and curved surfaces, and learn to manage them. The smaller the gas bag, the less the resistance of the air; consequently a greater velocity; consequently a greater lift of the aero-surfaces; and again a less demand upon the hydrogen —and so on, to final victory. American skill, ingenuity and experience will triumph provided that experience is cumulative. Men must learn from twenty failures how to succeed the twenty-first time in one thing. As I said: Patience, money and time are necessary. I wish Andrew Carnegie, or some other 'captain of industry' who is in danger of dying rich, would establish and endow an 'aeronautical experiment station and laboratory,' and then place it in charge of a physicist like Professor Zahm, and an accomplished mechanical engineer like Mr. Blank. In ten years such men, under such conditions, would go far towards a solution of the problem of aerial navigation.

FUNDAMENTAL PRINCIPLES.

Some one proposed to teach a nation patriotism by writing popular songs for its schools. There was a world of wisdom in the suggestion, for the foundations of character and the guiding principles of life are generally laid at school. That is why the great teacher is such a power in the world.

Is it not so in engineering? Are not a few fundamental propositions of mechanics what one must fall back upon when a new problem is encountered? And does not the probability of one's seeing new problems and of solving them depend very largely upon one's absolute mastery of those few fundamental propositions? If you agree with me and answer these questions in the affirmative, then it follows, in our opinion at least, that the lines of progress in engineering will depend largely upon the com-

plete equipment of our schools and the thoroughness with which the basic doctrines are instilled into the life blood of the students. It is said of Benjamin Franklin that he could not take a walk nor go on a journey without seeing all about him unsolved problems and new illustrations of universal laws; and with Franklin to see a problem was almost the same as to solve it.

MANUAL TRAINING.

I can not close this rambling address without referring to a recent improvement in secondary education which is likely to affect favorably engineering education, and through that education promote the future of engineering itself. I refer to the introduction into high schools and academies of the study of tools, materials and the mechanical processes. At the age of fifteen the expanding boy feels the thrill of increasing strength, and a natural hunger and thirst for contact with material things. The instinct to handle things, to do things, requires guidance or it becomes belligerent and destructive. The material universe is to be solved by every one for himself; if in no better way, it will be by pulling things to pieces to see how they are put together; by breaking things to see how strong they are; and by making new things if he only know how.

Then and there are the time and place for manual training; not for a trade or a profession, nor even for fun and pleasure; but for culture and a conscious mastery of tools and materials, and of the arts of construction. During the secondary stage of education the student should find himself and get an intelligent insight into the world of mind and matter around him. Both inborn aptitude and external opportunity should justify the coming engineer. The new educational feature goes far to develop the one and to discover the other. The fruit of well-organized and logical manual training is clear thinking, strong, vivid concepts, a world of knowledge gained first-hand, a power and habit of mental analysis of concrete problems—all of which admirably prepare the boy to take up, as a man, the study and practise of engineering. We have all seen something of this rich fruit, and have tested its value. In my judgment, it bodes well for engineering. Like Franklin, these young men (and they are swarming through our manual training schools and knocking in increasing numbers at the doors of our technical schools and colleges) will see things, and solve things, and make things move. The promise of the future is glorious; splendid is the era now dawning; fortunate in their opportunity are the young engineers with clear heads and skilled hands who are coming to the front; and happy are we who, to the best of our ability, are helping on the higher civilization which good engineering makes possible.

CALVIN MILTON WOODWARD.

---

*PROBLEMS IN HUMAN ANATOMY.**

FOR the solution of the problems presented to him, the anatomist is by no means limited in his technique to the scalpel or the microscope, but justly claims the right to use every aid to research which other departments of science are able to furnish. His position, therefore, in the scientific field is determined by the standpoint which he occupies and from which he regards animal structures, rather than by any special means and methods employed for their study.

By common consent, anatomical material includes not only structures which may be easily dissected and studied with the unaided eye, but also those which tax the best

* Address prepared for the Section of Human Anatomy at the International Congress of Arts and Science, at St. Louis. Owing to the unavoidable absence of the writer, this address was not delivered.

powers of the microscope for their solution. But even within such wide limits the material that ordinarily comes to hand leaves much to be desired, and in elucidating this or that feature in the structures under examination, it is often found necessary to modify the physiological conditions under which these structures have been working, in the hopes that their appearance may be altered thereby, and so be more readily understood.

Taken in a broad way, this is the reason why the data of pathology and experimental morphology are so important for the development of anatomical thought, helping as they do in the solution of the problems connected with the finer structure of the animal body, just as embryology and teratology illuminate the gross morphological relations in the adult.

I am quite aware that in making the foregoing statements I have suggested more modes of investigation than are at present used in connection with man. But the anatomy of the human body in adult life forms in itself so limited a field that no investigator can possibly confine himself to this portion alone, and there is every reason for here treating the subject in the larger way. As we see from the history of human anatomy, it was brought into the medical curriculum in response to the demands both of physiology and surgery, but gradually became most closely associated with the latter. For a long time its relative significance as a medical discipline was very great, because it represented the only real laboratory work which appeared in the training of the medical student. Indeed, a generation ago the exactness of anatomical methods was so lauded in comparison with the methods then commonly used in medicine, that anatomists came to scoff at the vagueness of their colleagues, while to-day, if we may be persuaded by some of our physiological friends, they have remained only to prey on the time of students who might be better employed. Although such a thrust may be readily parried, it is, nevertheless, necessary to admit that times are changed, and that as a laboratory exercise human anatomy is today outranked by several of the subjects in which the laboratory work permits a more precise formulation of problems and their more rapid and definite solution. However, it still retains, rightly enough, much of its former eminence.

Among the problems in human anatomy, there is, perhaps, none more important than the way in which it is to be presented to the five young gentlemen ranged around a subject in the somewhat trying atmosphere of the dissecting room. Just what they may be expected to learn from such an experience would require some time to state. Certain it is that these beginning anatomists are almost all of them intending to become physicians, and some of them to become surgeons, and to this end they are building up a picture of the human body which will be useful to them in their profession. They are doing this by the aid of the best pedagogical means at their command, namely, the reinforcement of the ocular impressions by the contact and muscular sensations that come from the actual performance of the dissection itself. If previously they have had some experience in the dissection of the lower mammals, they will note at once the differences shown in the case of man, and if their embryology is at their command, it will be easy for them on suggestion or on their own initiative to appreciate how some of the peculiar relations between parts of the human body have been developed. Beyond this the information obtained is of the same order as that of the vocabulary of a language. The student gets a certain number of discrete pictures of the different parts of the body more or less clearly im-

pressed upon his mind, and when he has occasion later to deal with these same parts, he has the advantage of finding himself in the presence of familiar structures. How far in this first experience the special groups of facts which are sometimes set apart under the head of surgical anatomy should be introduced, is a more or less open question. The present weight of opinion demands that they should still be kept by themselves. Nevertheless, while the anatomical experience of the average medical student should rest on a broad scientific background, he should at the same time have a distinct appreciation of the eminently practical value of the information he is expected to acquire.

The question at once arises how the monotony of long-continued dissection can be relieved, and the student maintained in a condition of sufficient receptivity to make the work really worth while; for the acquisition of vocabularies has never been counted as one of the greater pleasures of life. There are several legitimate devices. In the first place, if it is possible for the student to have near at hand a microscope which may now and then be used for the examination of the different tissues as they appear in the cadaver. This cross reference between the gross and microscopic appearance will serve to bring into close connection with one another two classes of facts which are often separated to their disadvantage, and to revive the histological pictures which should be incorporated in gross structures, but which in most cases remain forever apart from them. On the other hand, a search for anomalies or variations serves to give both a reality and purposefulness to the work and to make a student feel that in return for the large amount of time necessarily required for his anatomical training, he is, in some small measure at least, contributing to the science. It is unavoidable, this expenditure of time, and absolutely necessary, that the student should do these things with his own hands in order to obtain the three-dimensional impression of the structure with which he deals.

In this connection just a word as to the way in which the beginner may be aided in the comprehension of his work. The excellent diagrams and pictures which are now used to illustrate the best anatomical text-books carry us as far as that means of assistance can probably go. Pedagogical experience points strongly, however, to the superior value of the three-dimensional model, and although such models are more difficult to collect, harder to care for, and require more space and caution in their use, they are so far superior to any other device, except an illustrative dissection itself, that the collection of them in connection with anatomical work becomes a moral obligation.

If we turn now to the wider uses which may be made of anatomical material as it usually appears in the dissecting room, we find that a number of directors of laboratories have been utilizing this material for the accumulation of data in such a form that it may be later treated by statistical methods. Thus they have weighed and measured in different ways various parts of the cadaver, and in some cases determined the correlations between the organs or parts examined. It can not be too strongly emphasized that the results thus obtained are to be used only with the full appreciation of the fact that the material ordinarily available for examination in the dissecting room belongs in all countries to a social group which contains the highest percentage of poorly developed and atypical individuals. The conclusions, therefore, that can be drawn from the investigations of this material must always be weighted by its peculiar nature. To illustrate what is here meant by the pe-

culiar character of this material, we may take as an instance the bearing of the results obtained from material of this sort on the problem of the brain weight in the community at large. It must be admitted that the figures which we have at our command for this measurement are, with the exception of one short list, derived from the study of individuals belonging to the least fortunate class in the community, and it is not fair, therefore, to carry over these data and apply them directly to the average citizen who is of the normal type and moderately successful in the general struggle for existence. From what has been said, it is plain that much of the work now being carried on in the dissecting room comes very close to the lines which have been followed for years by the physical anthropologists, yet because these have for the most part concerned themselves with the study of the skeleton, have limited their comparisons to the various races of men and have developed no interest in surgery, they have for a long time stood apart, and only recently joined forces with the professional anatomists. This step has certainly been to the advantage of anatomy, and as one result of it, anatomical material not previously utilized will now be treated by statistical methods. But all the work to which reference has here been made is on the body after death. So manifest are the disadvantages arising from the conditions which are thus imposed, that the necessity is felt on all sides of extending our observation as far as possible to the living individual. As an example of such an extension, we have the determination of the cranial capacity and brain weight in the living subject which has resulted from the labor of Karl Pearson and his collaborators.* The methods which have been employed for this purpose are capable of giving as accurate results as are ordinarily obtained from post-mortem examinations, and, moreover, have the advantage of being applicable at any time to any group in the community which it is desired to investigate.

To redetermine, as far as possible, from studies, on the living, all the relations which have been made out, post-mortem becomes a very immediate and important line of work.

But even under the general limitations which apply to the dissecting room material, it is desirable to refine our knowledge of the human body by classifying the subjects according to race, and thereby bringing into relief the slight anatomical differences that exist between the well-marked races of Europe and the races of other parts of the world. The history of anatomical differences due to sex lacks several chapters, and it is possible also to show the modifications of structure which come from the lifelong pursuit of certain handicrafts which call for peculiar positions of the body or for the unusual exercise of certain muscles; as, for example, the anatomy of a shoemaker.*

Such results as the one last mentioned have a direct bearing on the modifications of the human form which may be introduced by peculiarities of daily life and work, and bring anatomy into connection with the problems of sociology; while, on the other hand, both lines of work are contributory to the broader questions of zoological relationship and susceptibility to modification.

Yet when we have gained all the information which the scalpel can give, there still remains the whole field of finer anatomy, the extent of which it is so difficult to appreciate.

While recognizing that the human body

* Pearson and collaborators, *Phil. Trans. Roy. Soc.*, 1901.

* Lane, W. A., *Journ. of Anatomy and Physiology*, Vols. XXI. and XXII., 1887 and 1888.

may be regarded as a composite, formed by the fitting together of the series of systems, and while in some instances we have more or less accurate notion of the way such a system appears—as, for instance, in the case of the skeleton—yet a much better understanding of the relation of the soft parts would follow an attempt to extend this method of presentation, and to construct phantoms of the body in the terms of its several systems in some way which would show us the system in question as an opaque structure in a body otherwise transparent. This is, of course, the final aim of the various corrosion methods, or those which depend on injection or differential coloration of structures which may be viewed in three dimensions.

When the vascular, lymphatic, nervous and glandular systems can be thus exhibited for the entire body, or for the larger divisions of it, it will be possible to see the human form transparently, and to see it whole; a feat difficult to accomplish, but worthy of earnest endeavor. The development of such phantoms should serve to make more impressive the familiar fact that in many organs and systems the total structure is built up by a more or less simple repetition of unit complexes, as, for example, the liver by the hepatic lobule, the bones by Haversian systems, and the spinal cord by the neural segments.

If we pass now from the consideration of the systems of tissues to that of their structural elements, we enter the domain of histology and cytology. Starting with the differentiation of the tissues by means of empirical staining methods, investigators have gradually come to appreciate the chemical processes which underlie the various color reactions, and as we know now, there already exist methods for determining in the tissues several of the chemical elements, such as iron, phosphorus, etc., to say nothing of the more or less satisfactory identification of complex organic bodies by means of definite reactions. This being the case, it is possible to imagine representations of the body built up on the basis of these micro-chemical reactions, representations which would show it in the terms of iron or in the terms of phosphorus, thus yielding us an image which might be compared with that obtained by aid of the spectroscope when the picture of the object is taken by means of one out of the several wave-lengths of light which come from it.

The contemplation of the multitudinous opportunities for investigation and comparison which appear within this field, lead us to pause and inquire what is properly the purpose of all this anatomical work; for without a strong guiding idea we are liable to repeat the errors of earlier generations, and merely accumulate observations, the bearing of which is so remote from the actual course of scientific progress that the investigations are mainly useful as a mental exercise for the individuals who conduct them. Anatomical results begin to have a real meaning only when correlated with physiology, and when we learn that a tissue with a certain structure is capable of performing given functions, we feel that we are really bringing our anatomy into touch with the life processes. It is to aid in the accomplishment of this end that men devote their lives to anatomical work. With the variation that we find everywhere in organic structures, it should be and is possible to discover by comparison what variations in the structure of a tissue or a cell are accompanied by the best physiological responses. It is along this line that we must necessarily work in order to reach human life either through medical practise or through other avenues of approach, for in the end the object and purpose of all science is to ameliorate the unfavorable conditions

which surround man, and in turn to produce a human individual more capable of resistance to disturbing influences, and better suited for the enjoyment of the world in which he lives.

Considering anatomical work with this thought in mind, the problems which it presents can be grouped according to their relative value and importance. The approach may be made from two sides. On the one hand it is, for example, extremely worth while to direct years of labor to the determination of the finer structure of living substance, because the more closely we approximate to a correct view of that structure, the more readily will our anatomy and physiology run together, and the clearer will be the conception of the sort of structure which it will be most desirable to increase for the attainment of our final purpose. On the other hand, if we follow the path from the grosser to the finer anatomy, we are led to inquire whether there is any one part or system of the human body which at the present moment is specially worthy of attention. When we say that the nervous system is such a part, I think that even those who are not engaged in the study of it will admit that there are some grounds for the statement. The peculiar feature which sets the nervous system apart is the fact that its enlargement, both in the animal series and during the development of the individual, is in a very special way accompanied by changes in its physiological and psychological reactions. To be sure, we think of it as built up fundamentally by the union of a series of segments, but the relationship established between these segments becomes ultimately so much more important than the constituent units that in the end we find ourselves working with a single system of enormous complexity rather than a series of discrete units, a state of affairs which is not paralleled in any other tissue. In addition to this, the nervous system as a whole is par excellence the master system of the body, and as such, the reactions of the organism are very largely an expression of its complexity. Indeed, within the different classes of vertebrates, the various species may be regarded as compound bodies composed of four fundamental tissues and a species could well be defined by the quantitative relations found to exist between the nervous, muscular, connective and epithelial constituents. Working from this standpoint, Dubois,* the Dutch anatomist, stimulated by the work of Snell,† has brought forward evidence for the view that when, within the same order, several species of mammals similar in form, but differing in size, are compared with one another, the weight of the brain is found to be closely correlated with the extension of the body surface, and by inference with the development of the afferent system of neurones. This view would seem to imply that in these cases there is the same density of innervation of each unit-area of skin; but the correctness of this inference can only be determined by the careful numerical study of the afferent system of the animals compared. It will appear, however, that under the conditions imposed, the relative weight of the brain depends upon the fact that each unit-area of skin, represented by the nerves which supply it, calls for a correlated addition of elements to the central system, and thus the increase in one part is followed by a corresponding increase in the other. When, however, the large and small individuals within the same species are compared, it is found that the increase in the brain weight follows quite another law, and that in this latter case it is relatively much less marked than in the former. This

* Dubois, *Archiv f. Anthropologie*, 1898.

† Snell, *Archiv f. Psychiatrie u. Nervenkrankheiten*, 1892.

result at once suggests that the mechanism of the increase is dissimilar in the two cases. For the solution of the problems that are raised by such investigations as those just cited, we need to employ quantitative methods, and on this topic a word is here in place.

Microscopic anatomy and histology, like all the sciences, have passed through a series of phases which are as necessarily a part of their history, as birth, growth and maturity are a part of the life history of a mammal. The microscope in its early days enabled Schwann to propound the fruitful theory that the tissues were composed of cells. A preliminary survey showed that these cells were different in their form and arrangement in the different parts of the body, and a still more careful examination with the aid of various dyes or solutions altering the tissues in the differential way gave the basis for yet finer distinctions. This phase in the development of the science, however, may be fairly compared with qualitative work in chemistry, where the object is to determine how many different substances are presented in the sample examined. Naturally, the next step is the introduction of quantitative methods, and we are, therefore, now using the methods of weighing, measuring and counting for the purpose of rendering our notions more precise, and thereby facilitating accurate comparisons. When emphasizing this point, we do not, however, forget that hand in hand with this quantitative work the qualitative tests have been marvelously refined, and that these necessarily form the foundation for quantitative work, since all such work must deal with the elements or groups of elements which can be sharply defined, and the basis for their definition is given through qualitative studies. As progress is made along these lines, we appreciate more and more that it is of importance for us to know not only how much brain and how much spinal cord by weight normally belong to a given species of animal, but also the *quantitative relations* of the different groups and classes of elements which compose these parts. We are continually asking ourselves how far the range in gross weight of the central nervous system may be dependent on changes in the number of elements in the different divisions or localities, and how far dependent on the mere increase in the bulk of the individual units without any change either in their absolute number or relative size. Work along this line rests, as we know, on the neurone theory, that epoch-making generalization concerning the structure of the nervous system which was put forward by our honored colleague, Professor Waldeyer.* Most of us are aware that, at the moment, this theory is the subject of lively and voluminous discussion, and that Nissl,† for example, urges the inadequacy of the conception on the ground that it does not account for the gray substance in the strict sense.

No one can fail to appreciate the very great importance of the satisfactory conclusion of the present dispute, and earnestly desire that we may obtain conclusive evidence on points involved; but however the question of the gray matter may be settled, the enormous importance of the neurone conception, and the value of it for the purposes of the microscopic analysis of the nervous system, will remain untouched, while our quantitative determinations applied to the neurone as we now understand it, will still have a permanent value.

Returning to the questions which are raised by the previously mentioned investigations of Dubois, we require in the first instance to determine the number of neu-

* Waldeyer, *Deutsche medicinische Wochenschrift*, 1891.

† Nissl, 'Die Neuronenlehre und ihre Anhänger,' 1903.

rones connecting the skin with the central nervous system, and to see how this number varies in the different species of mammals similar in form but unlike in size. There is only one animal, the white rat, on which as yet such studies have been made, so that the whole field lies practically open. Should we be able to get good numerical evidence in favor of the view that under the conditions named above, the afferent system could be taken as an index of the size of the brain, it would show us at once that in the laying down of the nervous system certain proportions were rather rigidly observed, and bring us to the next step, namely, the determination of the influences which control those proportions and the possibility of effecting an alteration in them. In the meantime, there is every reason to prepare for the application of these results to man, and although the program here is simple enough to state, it will involve great labor to carry it through.

So far as the numerical relations in man are concerned, we have, through the work of Dr. Helen Thompson,* an excellent estimate of the number of nerve cell bodies in the human cortex, and through that of Dr. Ingbert,† a reliable count of the number of medullated nerve fibers in the dorsal and ventral roots of the thirty-one pairs of spinal nerves of a man at maturity. It is easy to see, however, that we must get some notion of the amount of individual variation to which these relations are subject within the limits of one race and one sex before it is desirable to attempt to learn whether the difference in race or sex here plays an important rôle. It is to be anticipated, however, that the differences dependent upon race and sex will be comparatively slight, and especially so when contrasted with the differences which we may anticipate as existing between the adult and the child at birth. This aspect of the problem illustrates, in a concrete form, the sort of question which is raised by the anatomical study of the body during the period of growth. The embryologists have worked out the formation and early developmental history of the various organs and parts of the human body, but the study of the later fœtal stages have been blocked by the scarcity of material, and the inconvenience of dealing with it. On the individual at birth, we have again more extensive observations, but for the period comprised between the first two years of life and the age of twenty our information is again scanty. The lower death rate during this part of the life cycle, as well as social influences, combine to keep material between these ages out of the dissecting room. Here is an important part in the life history of man which needs to be investigated along many lines, and during which it is most desirable to have a record of the changes in the nervous system expressed in quantitative terms. In the general problem which is here under discussion, our next step would be to enumerate in man at birth the medullated nerve fibers in the roots of the spinal nerves. Such an enumeration will probably show us between birth and maturity a very large addition to the number of these fibers, but we still have to determine at what portion of the period, and according to what laws, this addition takes place. At this point our observations on animals will assist us, and we should certainly look for the occurrence of greatest addition during the earlier part of the growing period.

Let us assume then that we have obtained results which show us the normal development of this portion of the nervous system between birth and maturity. These observations could be used as a standard. Once possessed of such a standard, we are

* Thompson, *Journ. of Comp. Neurol.*, 1899.

† Ingbert, *Journ. of Comp. Neurol.*, 1903 and 1904.

prepared to determine variations in the nature of excesses or deficiencies, and in this instance the question of deficiencies is the one most easy to handle.

The studies of Dr. Hatai* on the partial starvation of white rats during the growing period show that very definite changes can be brought about in the nervous system when these animals are deprived of proteid food for several weeks. As a result of such treatment, the total weight of the nervous system is reduced much below that of the normal rat. Such a result, however, leaves two points still undetermined; (1) the general nature of the changes bringing about a diminution in weight, and (2) the parts of the system in which changes occur. In testing our animal material by quantitative methods, we should in the first instance direct attention to a possible decrease or arrest of growth in the afferent system of sensory nerves, and seek to determine whether the unfavorable conditions have not retarded the growth process in this division of the nervous system. If the results of such observations are positive, we may expect to find a corresponding modification in man, when the human body during the period of growth is subjected to unfavorable conditions of a similar nature. As a matter of fact, such unfavorable conditions do exist in the crowded quarters of our larger cities, and it seems highly probable that we have there in progress examples of partial starvation quite comparable with the experiments conducted in the laboratory. Under these circumstances, it is important to discover in the case of our animals how far a subsequent return to normal food conditions will modify the anatomy of a nervous system which has been subjected to proteid starvation for some weeks. At present there are no observations which indicate whether or no recovery in the nervous system will take place, and it will probably require some time to reach a definite conclusion. The work necessary for a determination of the anatomical changes exhibited by the animals alone constitutes by no means a light task, since in order to obtain reliable results and to eliminate the factor of individual variation a series of individuals must be examined, and it requires a very definitely sustained interest to carry through the long line of enumerations necessary for such an investigation. The examination of the growth of the nervous system in animals subjected to definitely unfavorable conditions, is, however, only one part of the work.

* Hatai, *American Journal of Physiology*, 1904.

It will be necessary to contrast the changes there found with the effects of special feeding, care and exercise in other groups, in order to see how far above the ordinary form the nervous system can be anatomically improved by any such treatment, and experiments in this direction are already being conducted by Dr. Slonaker. Of course the results which have been obtained and may be obtained on the animals studied in this way should not be directly applied to the case of man, because it seems quite evident that the higher organization of man is responsible for his ability to resist to a remarkable degree the disturbing effects of an unfavorable environment. The impression is abroad that the reverse is the case, and that it is man who is more responsive to unfavorable surroundings. I believe, however, that this current view will prove to be incorrect, for the lower mammals at least, and that when we place such animals where the conditions for them are abnormal, their limited powers of adaptability lead them to be more seriously affected than are animals which are more complexly organized. If such is the case, variations of the same amount should not be expected to appear in man, but there is every reason to assume that the variations

which do appear will be of the same general character and that we might look for them in the human nervous system where we find them in that of the rat. When it is possible to see how the anatomy of the nervous system may be altered during the post-natal growth period, we shall be prepared to take up the problem of how it may be improved during embryonic and fœtal life, and how the actual number of potential neurones is determined, and their relative distribution controlled, and this should lead ultimately to the attempt to breed animals with improved nervous systems in which we shall know the nature of the improvement in considerable detail.

It may be urged that putting the problems in this way indicates a greater interest in the application to physiology of the anatomical results than in the results themselves. But I take it that the interest of a machinist in building a machine is to make the parts for one that will go, and that no less honor is due him for his painstaking care in determining the construction of the different parts and their right relations, because at the end of the operation he has devised something capable of doing work. Similarly, it is possible that a man's interest from day to day shall be absorbed in the technique of anatomical science, and yet it is nevertheless distinctly advantageous, if his anatomical observations bear on the performances of the living animal, and a final result is obtained which is the synthesis of research in two associated fields.

In drawing up the preceding outline, no one is more aware than the writer of the fact that problems connected with the nervous system have alone been considered. Without doubt those more interested in the other systems of the human body could duplicate for these the problems which have been suggested in connection with the nervous system, so that the account given above may be taken simply as an illustration of the sort of thing that seems worth doing. In presenting these illustrations it has been my purpose to indicate a standpoint from which the anatomical problems can be profitably regarded, and to draw attention to the use of quantitative methods in the study of anatomy, and especially as applied to the body during the period of active growth.

Yet perhaps the largest of our problems and certainly one which appeals to all of us, is the ways and means for the solid advancement of our science. Alongside of the question of how we shall hand down to successive generations of students the facts already established, lies the still more fundamental problem of the best method of building up the body of anatomical knowledge.

It is not my purpose to advocate as a means to this end the sharp separation of teaching from investigation. It is a rare man who can stand the strain of such a division, whether he chooses one or the other, and there is, moreover, much to be said for such an arrangement as will bring the average student into a laboratory where he can himself see how research work is conducted. Yet it would be possible to name institutions in which the relative amount of time required for teaching as compared with that left free for investigation might with advantage be readjusted, and almost all of our educational institutions at the same time admittedly lack the funds, and not often the educational purpose, which would justify them in attempting to meet the various difficulties connected with anatomical investigations on a large scale. Yet no one questions the importance of striving for a more rapid advance. A response to this feeling finds its expression in the several research funds which are now available in this country and abroad for the endowment of investigation, and in the plan presented to the In-

ternational Association of Academies, and, it should be added, largely due to the initiative of Professor Waldeyer, for the establishment in various countries, of special institutes for the furtherance of research in embryology and neurology.

These two subjects were first selected owing to the peculiar difficulties of obtaining the needed material, and the great labor necessary to prepare the complete series of sections which are required in many cases. These conditions make it imperative that if we would avoid large loss of labor and much vexation of spirit, the work in these lines should be coordinated, standards adopted and the material of the laboratory, like the books of a library or the specimens in a museum, be available for the use of other investigators. Nothing, I believe, is further from the minds of those engaged in this plan than an attempt to produce anatomical results on a manufacturing scale. But the questions calling for solution in the fields here designated are so numerous, that such an arrangement will merely mean a subdivision of labor in which each institute will take one of the larger problems and direct its main energies to the study of this, so conducting the work that it shall be correlated with that in progress elsewhere. The director of such an institute will be justified in extending his work through assistants just as far as he can carry the details of the different researches in progress, and thus knit them into one piece for the education of himself and his colleagues. When we pass beyond this limit, admittedly subject to wide individual variation, there is little to be gained, but the evils of excessive production, should they arise, carry within themselves the means of their own correction.

This step, which is assuredly about to be taken, should enable us in the future to do things in anatomy not heretofore possible, and when, some years hence, there is another gathering of scientific men, with an aim and purpose similar to that of the present one, it is easy to predict that we shall be able to listen to a report on the important advances in anatomy arising from coordinated and cooperative work.

HENRY H. DONALDSON.
UNIVERSITY OF CHICAGO.

SCIENTIFIC BOOKS.

Ideals of Science and Faith. Essays by Various Authors. Edited by the REV. J. E. HAND, editor of 'Good Citizenship.' New York, Longmans, Green & Co. 1904.

Were this book not remarkable in itself, its motive would render it remarkable in any case. We readers of SCIENCE devoted, most of us, to absorbing technical subjects, may well peruse it to our great advantage, and realize a few tendencies of the day, unfamiliar to us maybe, and assuredly not clear in their main outlines.

The plan of the work is novel, even daring, and conjures up piquant expectancy. It consists of ten essays, each from a different hand, and divided into two groups. The first group, of six, under the general title 'Approaches through Science and Education,' deals with the possible contemporary relations between science and religion (relations of an irenical nature) from the standpoint of the lay expert. The subjects, and the authors who speak for them, are as follows: 'Physics,' Sir Oliver Lodge; 'Biology,' Professor Arthur Thomson, of Aberdeen University; 'Psychology,' Professor Muirhead, of the University of Birmingham; 'Sociology,' Mr. Victor V. Branford, secretary of the Sociological Society of London; 'Ethics,' the Hon. Bertrand Russell, fellow of Trinity, Cambridge; 'General and Technical Education,' Professor Patrick Geddes, University Hall, Edinburgh. The second group, of four essays, entitled 'Approaches through Faith,' presents the clerical standpoint in its various phases as follows: 'A Presbyterian Approach,' the Rev. John Kelman, of Edinburgh; 'A Church of England Approach,' the Rev. Ronald Bayne; the Rev.

P. N. Waggett contributes an essay entitled 'The Church as Seen from the Outside,' in which he concludes by stating the High Anglican, as opposed to the so-called Erastian, view; while, very fittingly, Mr. Wilfred Ward speaks for the Church of Rome. The editor furnishes a worthy introduction.

Obviously, in such a collection, comparisons were odious. But it may be of interest to state that the freshest essay comes from the newest science—sociology—and that it is supplemented by Professor Geddes' paper, which represents the same general outlook. The most striking contribution is that of the Hon. Bertrand Russell, who drives home the problem under review, nothing extenuating in the logical consequences of modern scientific research. One may add, further, that, for American readers, the book can not fail to possess additional suggestiveness because written under British influences. In other words, when more of our scientific men find it possible to write like Sir Oliver Lodge, Professor Arthur Thomson and the Hon. Bertrand Russell, and when more of our religious mentors can speak like the Rev. John Kelman and the Rev. Philip Napier Waggett, we shall be in far better position to 'get together' for the discussion of subjects now agitated or about to be agitated. To render my meaning plainer; I fear that an American botanist, speaking of his Presbyterian brethren, would scarcely find warrant for such a pronouncement as this: "So changing are the times that there seems nowadays to be more independent and speculative thinking among the aspirants to the Scottish ministry, once so strict, than among those of the university faculties of medicine, once and again so comparatively free; at any rate, since Robertson Smith, there has probably been less general ignorance of the results, and even of the methods of scientific research among the students of the older faculty than of the more modern one" (p. 185). Undoubtedly, conditions obtain in the old country that we do not enjoy, for there the *university* attitude, in contradistinction to that of the usual *theological seminary*, exercises much more potent sway over candidates for the ministry. Hence, perhaps, the possibility of such a book as this.

No doubt the work is tentative, not conclusive. No doubt one of the ecclesiastical contributors alludes darkly to a possibile double truth—one for science, another for religion, and a second openly adopts this doctrine, which really evades the entire question at issue. But, even so, the collection remains notable and, as I indicated at the outset, has everything to recommend it to reflective men, no matter on which side of the fence their main presuppositions happen to lie. Moreover, the brilliant criticisms of educational formalism, supplied by Mr. Branford and Professor Geddes, can not fail to set us thinking with reference to some of our own potent, if intangible, academic problems.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Plant World*, the official organ of the Wild Flower Preservation Society of America, now in its seventh volume, will, on January 1, come under the editorial management of Professor Francis E. Lloyd, head of the department of biology in Teachers College.

The Journal of Comparative Neurology and Psychology, for November, has as the leading article a paper of seventy pages entitled, 'The Behavior of *Paramecium:* Additional Features and General Relations,' by H. S. Jennings. On the basis of a summary of previous work on *Paramecium*, experimentally controlled, and a large body of new observations the reactions of this type are critically analyzed and its 'action system' formulated. The discussion of the nature of stimulation and of the reactions of *Paramecium* in detail gives further support to the author's claim that the current theories of tropism need radical revision. The number further contains an editorial by Dr. Yerkes on 'Physiology and Psychology' and a biographical sketch, with portrait and bibliography, of the founder of the journal and late editor-in-chief, Dr. C. L. Herrick.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

The December meeting was held at the American Museum of Natural History, Professor Underwood presiding. Papers were presented by Professor H. F. Osborn and Professor F. B. Sumner.

Professor Osborn exhibited newly prepared skulls of *Diplodocus, Morosaurus* and *Creosaurus,* from Wyoming. The skull of *Morosaurus* is new to science.

Under the title 'Recent Discoveries of Extinct Animals in the Rocky Mountain Region and their Bearings on the Present Problems of Evolution,' Professor Osborn exhibited a series of skulls of the Eocene ancestors of the Oligocene Titanotheres, stating as a result of recent investigations that the Oligocene Titanotheres were found to represent four distinct lines of descent in each of which horns independently developed, and that the Eocene forms also represented four distinct lines of descent, two of which became extinct, while the others gave rise to Oligocene forms. As bearing upon the general problem of evolution, it was pointed out that the paleontologist enjoys the peculiar advantage of following a series through the origin and development of organs to their subsequent progression or decline. As early as 1888 the speaker had taken the ground that various paleontological series demonstrate the *definite or determinate variations* of certain kinds. In 1892 he connected with this the idea that certain series of animals related by descent from a common stem form exhibit the *potential of similar evolution,* describing this as a law of latent or potential homology. It is now found in this series of Titanotheres that there is more than a potential of similar evolution; there is evidence of a predisposition to similar evolution as shown in the wholly independent development in two distinct series of horns from hornless types at exactly similar points on the skull, namely, at the lateral junction of the frontals with the nasals. (The communication had been in part presented before the Brooklyn Institute of Arts and Sciences, and before the Zoological Congress at Berne.)

Professor Sumner's paper was a preliminary note on 'Experimental Studies of Elimination and Selective Adaptation in Fishes.' Many experiments with the three common species of *Fundulus* tested the relative effect of asphyxiation and of gradual and abrupt changes of density in transferring from sea to fresh water and *vice versa.* Extended biometric studies point to the following conclusions: (1) the more and the less resisting individuals of a given species are different in type and in variability; (2) different methods of elimination result in selection with reference to different characters; (3) two closely related species were selected with reference to the same characters; (4) *Fundulus heteroclitus* from brackish water differ in all measured characters from those taken from the sea; (5) the differences of type in the three species of *Fundulus* are not due to natural selection acting with reference to the particular conditions which they are fitted to withstand.

M. A. Bigelow,
Secretary.

DISCUSSION AND CORRESPONDENCE.

STYLE IN SCIENTIFIC COMPOSITION.

Professor Eastman has recently (Science, XX., 807) criticized certain new terms in physiography, saying they are not in good taste. This, being interpreted, means that his esthetic judgments are different from those of the inventors of the terms; and I find too that my own judgments have individual peculiarities. Such discordance is surely regrettable; except for the entertainment of his graceful fault-finding we should all be happier if we thrilled or shuddered in unison. But how can harmony be attained? I question the efficacy of ridicule, which tends to strengthen rather than remove prejudices. The late Colonel Ingersoll, who made great use of ridicule, held that it had no power to convince, but could only confirm; and it was a favorite saying that he 'came not to convert sinners, but to comfort the faithful.' Is there not some way in which reason may be brought to bear

on the sins of terminology? Is it not possible by discussion to discover or develop principles of scientific nomenclature the establishment of which may make the canons of good taste general instead of personal? I have a suspicion that there are heavy battalions of argument back of Dr. Eastman's skirmish line of assertion; and so venture a few suggestions in the hope of drawing them to the front.

One suggestion is that utility may have an important bearing on our sense of fitness, or even elegance; that there may be a deep philosophic basis for the maxim 'handsome is that handsome does.' Is there not a tendency gradually to adjust esthetic judgments into conformity with rational judgments? Is not expressiveness, after all, the most admirable and the most admired quality of literary composition? And will not the system of technical nomenclature best adapted to practical needs become in the end most grateful to the esthetic sense?

In deprecating the belief of physiographers 'in the penury of the English language, and unsuitability of Saxon epithets,' and in stigmatizing the introduction of 'alien' words, Dr. Eastman seems to oppose the introduction of foreign words for the purposes of scientific terminology. As a large majority of new terms in science are either direct importations or else rearrangements of foreign material, and as the somatic growth of all languages is largely from alien sources, this view is, to say the least, radical, and should not be accepted without good reason. Have I possibly misunderstood him? Or is there a substantial basis for such an opinion?

He objects vigorously to the use of the humanistic analogy, and here I follow him so far as to admit that it has sometimes been carried too far. That is a danger to which all figurative language is exposed, but it is the ordinary danger from excess, and I would not therefore condemn the use of figures. Purely as a matter of literary taste I like the humanistic analogy in Eastman's 'rabble of words recruited from the uttermost parts'; and from the same point of view I like also Davis's characterization of the stages of the topographic cycle in terms of the cycle of human life. Eastman says the physiographic figure is founded on a 'false analogy,' but this I do not admit. The rhetorical quality of good analogy is close resemblance in some striking particular, coupled with difference in other respects; and that is precisely the relation between the topographic and human cycles. The stream valley resembles the human being in that from an early stage it evolves normally through a definite sequence of stages; and in most other respects the two differ.

But the characterization of topographic stages as 'youthful,' 'mature' and 'senile' is not a mere literary flower, the transitory decoration of a sentence; it is a part of technical terminology in continuous employment; and in that capacity its utility is of primary importance. In my judgment there are few groups of terms which serve better than does this group the purpose of concisely expressing an idea. Its strength inheres, first, in the aptness and completeness of the analogy, and, second, in the perfect familiarity of the group of facts to which the unfamiliar facts are likened. The physiographic stages have no precise limits, but grade one into another as parts of a continuous development; each one is so complex in its phenomena and so variable from individual to individual that sharp-cut definition is impossible; and in these respects they are strictly paralleled by the life stages. The aptness and the familiarity make the terms permanently mnemonic, so that the use of any one of them brings to mind not only the sequence, but relative position within the sequence. Davis's generalization had such merit that it would probably have found eventual appreciation, whatever its mode of expression, but I think that the promptness and universality of its acceptance and assimilation were in large measure due to the felicity of the associated terminology.

G. K. GILBERT.

WASHINGTON, D. C.

L'ANNÉE BIOLOGIQUE.

TO THE EDITOR OF SCIENCE: We learn that the annual *L'Année biologique* is in danger of being discontinued unless it receives addi-

tional support. One hundred more subscribers in this country would probably encourage the editors to go on with it. These ought not to be difficult to get. To those who are unacquainted with it we may say that it is quite unique and occupies a different and higher plane than most bibliographic works. There is not merely a more or less roughly classified list of titles and brief abstracts of contents, but a series of logically arranged *critical* reviews pointing out the bearing of the paper, reviewed on the state of knowledge of the subject. The systems of cross referencing and indexing are wonderfully complete. The reviews are arranged primarily into twenty chapters, as follows: Cell, sex products and fertilization, parthenogenesis, asexual reproduction, ontogenesis, teratogenesis, regeneration, grafting, sex and pleomorphism, alternation of generations, latent characters, correlation, death, general morphology and physiology, heredity, variation, origin of species and specific characters, geographic distribution, nervous system and functions, general theories. Most of these chapters are elaborately subdivided. A feature has been comprehensive reports on the state of our knowledge of special topics. No one who is interested in the development of the topics named above can view with equanimity the prospect of the loss of this review. It is to be hoped that every biological laboratory and every library that has a scientific department and which lacks *L'Année biologique* will at once send a subscription to Schleicher frères, Paris, the publishers, or to Professor Y. Delage, Sorbonne, Paris, the chief editor.

Chas. B. Davenport,
Jacques Loeb.

THE EPIDIASCOPE.

To the Editor of Science: Who saw the epidiascope at the St. Louis Exposition? It appears in the catalogue of German scientific instruments at page 211, and is a most interesting type of projection apparatus, of especial utility to all schools. The possibility of speedy and facile transition from reflected to transmitted light, if worked out to the last optical and mechanical detail, would render it worthy of wide adoption. The diffusion of knowledge of all the arts and sciences ought to be very materially enhanced by this perfected apparatus. The projection of printed pages, photographs, charts and works of art, all without the necessity of photography, is most important. The name of the inventor is not given: presumably Carl Zeiss, of Jena.

David P. Todd.

Amherst College Observatory.

SPECIAL ARTICLES.

THE INFLUENCE OF CAVERNS ON TOPOGRAPHY.

It is well known that caverns, particularly those in regions underlain by limestone, are frequently associated with depressions in the surface above them, such as sink-holes, or swallow-holes, as they are commonly termed. It is also a familiar fact that the falling of portions of the roofs of caverns sometimes gives origin to ravines, canyons, etc., which are occasionally spanned by remnants of the roofs which remain in place, as in the case of the natural bridge of Virginia, and in other similar ways influence surface relief. A characteristic feature of this class of topographic changes is that depressions in the surface of the land are produced. The class of land forms to which attention is here invited, however, are exceptional, and, as it seems, have not been recognized as having a direct association with caverns, for the reason that they stand in relief and in some instances are conspicuous and picturesque on account of their height and boldness.

The topography of most regions the world over owes its leading characteristics, aside from elevation above the sea, to erosion. The chief exceptions are elevations produced by volcanic and glacial deposition. Erosion, particularly by streams, leads to the production of two classes of earth features, one class being due to the removal of material, as in the excavation of valleys, while the other class includes the remnants of uplands left when erosion to a plane surface is incomplete. In the production of such topographic changes, weak rocks, as a rule, are removed most readily and are replaced by depressions; while resistant rocks persist longer and are left in relief.

By weak rocks is meant those which offer a comparatively small degree of resistance to the agencies of abrasion, such as streams, glaciers, etc., or yield readily to the solvent action of water; while resistant rocks are such as have the opposite attributes in these particulars. Certain rocks are weak in reference to both mechanical and chemical erosion; and of the members of this class limestone is by far the most common.

On account of its comparative softness and solubility, limestone is, as a rule, more easily removed during the process of denudation than the formations with which it is usually associated, and when it occurs at the earth's surface side by side with more resistant rocks, its presence is frequently indicated by a depression. So generally is this the case, particularly if the rocks referred to occur in essentially horizontal beds, that it is a surprise to find limestone forming bold eminences in a region which has been stable for a long time and in which pronounced mechanical and chemical denudation has occurred. Examples of limestone standing in bold relief in regions where, for the most part, these several conditions obtain, are furnished by Mackinac Island, situated in the western portion of Lake Huron, and by Gibraltar, the well-known rock-fortress, one of the Pillars of Hercules.

Mackinac Island has a circumference of about nine miles, and an area of 2,221 acres. It rises to an elevation of 317 feet above the level of Lake Huron, and the surrounding water within a mile of its shore is from 150 to 200 feet deep; its total height above the bottom of the partially submerged valley in which it is situated is thus in excess of 500 feet. The rock of which the island is composed is limestone, which dips very gently to the south, and at several localities has been eroded so as to form vertical lake-cliffs. Limestone belonging to the same geological formation occurs on the neighboring St. Ignace Peninsula, but excepting these two circumscribed localities, has been deeply denuded over an extensive region, and the depressions formed are now occupied by the waters of Lakes Huron and Michigan.

Gibraltar rises 1,349 feet above the surface of the Mediterranean, and the water within a mile of the borders of the peninsula is from 300 to more than 600 feet deep. The length of the promontory is about two and one half miles and its width from 550 to 1,550 yards.* It is composed mainly of limestone in highly inclined strata, and, as is rendered evident from its isolated position and the presence of similar limestone on the African side of the adjacent strait, is a remnant of a once extensive formation.

Mackinac Island and Gibraltar are similar in several particulars; for example, each one is situated on the border of a navigable strait, and is of great strategic importance, as history has demonstrated; but a more fundamental fact is that they are composed mainly of fissured and cavernous and in part brecciated limestone, which is thus rendered especially favorable for the downward percolation of water. The only conspicuous difference between the two elevations seems to be that the rock of Mackinac Island is essentially horizontal, while the rock of Gibraltar is steeply inclined. In each case bordering precipices are present which, no doubt, have been produced in part by under-cutting by waves and currents, but the isolation of the great rock masses themselves seems to be due to the lowering of the region about them respectively, and this lowering, as it seems most reasonable to conclude, has resulted from subaerial denudation. Precisely why bold remnants of formerly widely extended formations should have been left at these two localities, however, has, so far as I am aware, never been explained.

Another example of limestone standing in relief in a deeply denuded region, and one which is especially instructive in the above connection, is furnished by a low hill at

* A. C. Ramsy, and James Geikie, 'On the Geology of Gibraltar,' in *Quarterly Journal of the Geological Society of London*, Vol. XXXIV., 1878, pp. 505–541.

I should, perhaps, state in partial justification for presenting the present article, that I have visited each of the localities mentioned above, and have at least some first-hand information concerning them.

Luray, Va. The hill referred to has extensive caverns beneath it, and, as appears evident, has been left in relief owing to the more rapid denudation of the surrounding country; the reason being that rain falling on the area where the rock is cavernous percolated downward and was prevented from forming surface streams and in consequence lost its ability to mechanically erode, while the surrounding country where the existence of surface streams was possible was degraded more rapidly.

The influence of subterranean drainage, as must be well known although seldom mentioned, is frequently indicated by minor elevations, especially in limestone regions where joints and other openings permit of the ready descent of surface water. Similar conditions on a larger scale, as just stated, may reasonably be held accountable for the origin of the hill above the caverns at Luray, and seemingly furnish the basis for an hypothesis which meets the conditions present at Mackinac Island and Gibraltar. If this hypothesis is sustained by future tests, it not only furnishes an explanation of the origin of the elevations just mentioned, but embodies a principle which is widely applicable. For example, it is frequently stated in modern text-books of physical geography, that residual hills standing on plains of subaerial denudation or 'monadnocks,' owe their prominence to the greater resistance of the rocks of which they are composed, mainly because of their hardness, in comparison with the rocks about them; or have been spared on account of their geographical position, that is, they occur at localities where streams originated and flowed away in various directions, and in consequence were left in relief after the country about them had been conspicuously degraded. To these explanations of the origin of monadnocks a third may now be added, namely: If the rocks of a given area are more open and porous, or traversed by fissures or caverns to a conspicuously greater degree than the rocks beneath the surrounding region—the general elevation being sufficient to favor subterranean drainage—they may be left in relief because the water reaching them will be conducted away by means of underground channels and thus in a great measure and in general almost entirely deprived of its power to mechanically erode, while adjacent areas are not favored in this manner.

A consideration of all the known facts relating to the rocky heights forming Mackinac Island and Gibraltar indicates that at each of these localities a residual of the nature of a monadnock has been left as the region about it was lowered by erosion; the controlling condition being that the rocks left in relief are fissured and cavernous, thus facilitating subterranean drainage, while the country about them was denuded at a more rapid rate through the agency of surface streams.

Israel C. Russell.
University of Michigan.

A NOTABLE ADVANCE IN THE THEORY OF CORRELATION.

To Professor Karl Pearson the new science of biometry is indebted not only for its name, but also for those refinements and extensions of the methods of statistical analysis without which it would be far from occupying the position which it holds to-day. In the remarkable series of memoirs which have appeared under the general title 'Mathematical Contributions to the Theory of Evolution,' Pearson and his assistants have laid a foundation on which a superstructure of great import to biology can, and will be, reared. The most recent of the memoirs in this series* brings forth a very interesting extension of the theory of correlation which at once greatly widens the range of problems and material which can be effectively handled by biometric methods.

In the development of the method of determining the degree of correlation between characters not admitting of quantitative measurement,† it was thought necessary in forming the correlation table to arrange the classes

* 'Mathematical Contributions to the Theory of Evolution,' XIII. 'On the Theory of Contingency and its Relation to Association and Normal Correlation.' Drapers' Company Research Memoirs, Biometric Series, I., pp. 1–35, 2 pl., 1904.

† *Phil. Trans.*, Vol. 195 A, pp. 1–47, and pp. 79–160.

or subgroups of the characters in a definite order corresponding to the real (though in detail undeterminable) quantitative scale in the character or attribute itself. The order of the classes appeared to be the important thing, and consequently the method was assumed to be limited to such attributes as could be arranged in a definite scale order. In recent work, however, by varying the order of the classes Pearson has found that so far as the value of the correlation coefficient is concerned this group order has practically no influence. For the new conception of correlation which arose from a consideration of this fact Pearson proposes the term *contingency*.

As a measure of the *contingency* of any classification of characters, it is proposed to use some measure of the 'total deviation of the classification from independent probability.' The practical method of making such a measure Pearson develops in the following way.

"Let A be any attribute or character and let it be classified into the groups $A_1, A_2, \cdots, A_s$, and let the total number of individuals examined be N, and let the numbers which fall into these groups be $n_1, n_2, \cdots, n_s$, respectively. Then the probability of an individual falling into one or the other of these groups is given by $n_1/N, n_2/N, \cdots, n_s/N$, respectively. Now suppose the same population to be classified by another attribute into the groups $B_1, B_2, \cdots, B_t$, and the group frequencies of the N individuals to be $m_1, m_2, \cdots, m_t$, respectively. The probability of an individual falling into these groups will be respectively $m_1/N, m_2/N, m_3/N, \cdots, m_t/N$. Accordingly the number of combinations of B_v with A^u to be expected on the theory of independent probability if N pairs of attributes are examined is

$$N \times \frac{n_u}{N} \times \frac{m_v}{N} = \frac{n_u \cdot m_v}{N} = \nu_{uv}, \text{ say.}$$

"Let the number actually observed be n_{uv}. Then, allowing for the errors of random sampling,

$$n_{uv} - \frac{n_u m_v}{N} = n_{uv} - \nu_{uv}$$

is the deviation from independent probability in the occurrence of the groups A_u, B_v. Clearly the total deviation of the whole classification system from independent probability must be some function of the $n_{uv} - \nu^n_v$ quantities for the whole table." The value of any function of these quantities will clearly be independent of the order of classification.

The following functions of the $n_{uv} - \nu_{uv}$ quantities were chosen for practical use.

(*a*) $1 - P$; the *contingency grade*, where P is determined from χ^2 by the use of Elderton's tables.* The quantity χ^2 is a measure of the deviation of the observed results from independent probability, depending on the $n_{uv} - \nu_{uv}$ quantities as shown by the equation

$$\chi^2 = S\left\{\frac{(n_{uv} - \nu_{uv})^2}{\nu_{uv}}\right\},$$

where S indicates summation of like quantities over the whole table. A large value for $1 - P$ indicates that there is association between the attributes, while with a small value of this function the chances are that the system arose from independent probability.

(*b*) The function

$$\phi^2 = \frac{\chi^2}{N};$$

termed the *mean square contingency*.

(*c*) The function

$$\psi = \Sigma \frac{(n_{uv} - \nu_{uv})}{N};$$

where Σ denotes summation of all $n_{uv} - \nu_{uv}$ quantities *having the same sign*. This function ψ is called the *mean contingency*.

In determining the functions of ϕ^2 and ψ which shall be used practically, Pearson considers the relation of these quantities in the case of normal correlation. After some analysis the result is reached that

$$\phi^2 = \frac{r^2}{1 - r^2},$$

or

$$r = \pm\sqrt{\frac{\phi^2}{1 + \phi^2}}$$

in the case of normal correlation. This result proves at once that 'the coefficient of correlation is * * * entirely independent of the arrangement of our classes on the basis of any assumed order or scale.'

* *Biometrika*, Vol. I., p. 155.

This function

$$\sqrt{\frac{\phi^2}{1+\phi^2}}$$

is called the *first coefficient of contingency* and is denoted by C_1.

The analysis of the relation of function ψ in the case of normal correlation leads to the practical result that the value of r may be obtained if ψ is given, which, of course, is the case, the latter function being obtained from the observations. A table and plotted curve from which values of r correct to two places may be read off directly, are given. If the coefficient so obtained from ψ be designated as C_2 the *second coefficient of contingency,* we have as a *limiting case*

$$C_1 = C_2 = r$$

when the correlation is normal and the grouping is sufficiently fine. The approach of C_1 and C_2 to equality may be taken as a measure of the approach of the system to normality and of the correctness of the grouping.

An investigation into the problem of the probable errors of contingency coefficients leads to the result that the probable error of any contingency coefficient C may, for rough judgments, safely be taken to be less than

$$2 \times .67449 \frac{1-C^2}{\sqrt{n}}.$$

The percentage probable error of

$$\phi^2 = \frac{1.34898}{\sqrt{N}} \sqrt{\frac{1+\phi^2}{\phi^2}}.$$

After considering the subject of multiple contingency and its relation to multiple normal correlation the author proceeds to give some illustrative examples showing something of the sort of problems to which the method may be applied, and also how it is to be used in practise. The examples include (*a*) the correlation between father and son in respect to stature, (*b*) color inheritance in greyhounds, (*c*) fraternal resemblance in hair color in man, and (*d*) the correlation between father and son in respect to occupation or profession.

The net results brought out by the analysis and confirmed by the numerical illustrations may best be stated in the author's own words: "With normal frequency distributions both contingency coefficients pass with sufficiently fine grouping into the well-known correlation coefficient. Since, however, the contingency is independent of the order of grouping, we conclude that, when we are dealing with alternative and exclusive sub-attributes, we need not insist on the importance of any particular order or scale for the arrangement of the subgroups. This conception can be extended from normal correlation to any distribution with linear regression; small changes (*i. e.,* such that the sum of their squares may be neglected as compared with the squares of mean or standard deviation) may be made in the order of grouping without affecting the correlation coefficient." These results "are not so fruitful for practical working as might at first sight appear, for they depend in practise on the legitimacy of replacing finite integrals by sums over a series of varying areas, where no quadrature formula is available. If we, to meet the difficulty, make a very great number of small classes, the calculation, especially of the mean square contingency, becomes excessively laborious. Further, since in observation individuals go by units, casual individuals, which may fairly represent the frequency of a considerable area, will be found on some one or other isolated small area, and thus increase out of all proportion the contingency. The like difficulty occurs when we deal with outlying individuals in the case of frequency curves, only it is immensely exaggerated in the case of frequency surfaces. It is thus not desirable in actual practise to take too many or too fine subgroupings. It is found, under these conditions, that the correlation coefficient as determined by the product moment or fourfold division methods is approximated to more closely in the case of the contingency coefficient found from mean square contingency than in the case of that found from mean contingency. Probably 16 to 25 contingency subgroups will give fairly good results in the case of mean square contingency, but for each particular type of investigation it appears desirable to check the number of groups proper for the purpose by comparing with the results of test fourfold

division correlations. Under such conditions it appears likely that very steady and consistent results will be obtained from mean square contingency."

In the calculation of contingency coefficients the present writer has found that the following procedure saves much time and labor. The value of the independent probability ν_{uv} for each compartment of the table is obtained by the use of a Thacher calculating instrument (Keuffel and Esser). With this instrument one can read directly to four or five figures the values of any expression which can be put into the form ax/b, where a and b are constants and x is a variable. Since ν_{uv} for any compartment equals $(n_u \cdot m_u)/N$ for that compartment, it is evident that by taking either n_u or m_v as the constant, it will only be necessary to make as many settings of the instrument as there are rows or columns in the table. Having obtained the ν_{uv} quantities, the sub-contingencies $(n_{uv} - \nu_{uv})$ may be written down directly, squared from Barlow's tables, and divided by ν_{uv} with an arithmometer or with Zimmermann's or Crelle's multiplication tables. The remainder of the calculations necessary to obtain the mean square contingency and the whole of the calculations for the mean contingency, and their respective coefficients are, of course, easily performed. Proceeding in this way, the calculation of contingency coefficients, even though several experimental groupings are made, has been found to take but comparatively little time.

The noteworthy features of this method of contingency are found in that it, in the first place, broadens and illumines the whole theory of correlation, and in the second place, brings within the range of biometrical investigation a large series of problems to which it has hitherto been impossible to apply exact methods. One can but feel that this memoir, like so many of the others which have preceded it in the series, marks a definite and fundamental step in advance in the steady progress of the science of biometry.

RAYMOND PEARL.

'GLUCINUM' OR 'BERYLLIUM.'

SOME years ago the question of choice between the two names 'glucinum' and 'beryllium' was gone into quite carefully by Professor F. W. Clarke and also by the committee appointed by the American Association on the Spelling and Pronunciation of Chemical Terms, and the conclusion was arrived at that the name 'glucinum' should be used on the ground of priority. In SCIENCE for December 9 Dr. Charles Lathrop Parsons has stated his grounds for preferring the name 'beryllium.' Dr. Parsons is, thanks to his bibliographical work on the element in question, thoroughly informed in its literature, but the arguments adduced by him would seem to lead to a conclusion diametrically opposed to that which he has drawn.

It was obviously the privilege of Vauquelin, the discoverer of the element, or rather its oxid, to name it. This he never did, but contented himself by speaking of it at first as 'la terre du Béril,' that is, the earth in beryl. At the close of Vauquelin's first paper the editors of the *Annales* added a note signed 'Redacteur' in which they propose the name 'glucine.' It was of course well known that Guyton and Fourcroy were the editors. Vauquelin's second paper in the *Annales* was evidently prepared at the same time as the first, or at least before the second was in print. In his third paper, some weeks later, as Dr. Parsons admits, Vauquelin actually adopted the term 'glucine,' prefacing its use with 'on a donné le nom de glucine.' The paper in the *Journal des Mines* was apparently prepared at the same time as the first two papers in the *Annales* and before the appearance of the suggestion of Guyton and Fourcroy, but at its close occurs the note which Dr. Parsons has quoted. In this he states that Guyton and Fourcroy have advised him to call the new earth 'glucine' and while he evidently does not think the name the best that could have been chosen, he clearly acquiesces in the suggestion of the two great authorities and says 'Cette denomination sera assez significante pour aide le mémoire.' Finally, as seen above, in his third paper, he adopts the name. As far as priority goes, the argument in favor of 'beryllium' would seem to be that probably Vauquelin would have given the earth some other name had he ventured to dissent from

Guyton's authority, and it is probable that he would have liked to name it 'beryllia.' All of which may be quite true, but actually he did not do it.

As regards the German use of 'Berylerde' it was merely at first the natural translation of Vauquelin's expression 'la terre du Béril,' which, as we have seen, he used in no denominative sense. If the generally accepted rules of priority have any weight 'glucinum' is the only term to be used for the element.

As regards usage, the case is hardly quite as bad as Dr. Parsons seems to think, since the index to the *Journal of the Chemical Society* (London) for 1903 gives 'Beryllium, see glucinum.' With French, English and Americans using 'glucinum,' we can afford to let the German journals cling to 'beryllium' a little while longer.

Incidentally, what shall we do when the Germans insist on kalzium, kolumbium, karolinum, zerium and zesium, or will it be kæsium?

Jas. Lewis Howe.
Washington and Lee University,
December 12, 1904.

BOTANICAL NOTES.

THE STUDY OF FIBERS.

The book ('The Textile Fibers, their Physical, Microscopical and Chemical Properties') prepared by Dr. J. M. Mathews, and recently published by John Wiley, should make the study of textile fibers somewhat easier by students and practical operators. It covers nearly three hundred pages of neatly printed text, illustrated by sixty-nine cuts, in which the author has presented the whole matter in a most helpful way. There is first a useful classification of fibers, followed by descriptions and discussions of those which enter into fabrics. Some of these fibers are, of course, of animal origin, as wool, hair and silk, and to these are given about ninety pages. The remainder of the book is devoted almost wholly to plant fibers, and here the treatment is especially clear and helpful. The origin, varieties, physical and chemical properties of cotton, and mercerized cotton, are discussed in as many chapters. Linen is given another chapter, while jute, ramie, hemp and several other fibers of minor importance are disposed of in another chapter. An interesting chapter for the general reader is the one on artificial silks, the processes for the production of which 'have been attended with a considerable degree of success.' It is said that artificial silk 'has become a commercial article, and is used in considerable quantity by the textile trade.' Of these artificial silks there are four general kinds, viz:

1. Pyrozylin silks, made from a solution of gun cotton in a mixture of alcohol and ether.
2. Fibers made from a solution of cellulose in ammoniacal copper oxide or chloride of zinc.
3. Viscose silk, made from a solution of cellulose thiocarbonate.
4. Gelatin silk, made from filaments of gelatin rendered insoluble by treatment with formaldehyde.

Most of the artificial silk is of the first variety, the manufacture of which is carried on in England, Germany, France and Switzerland. "The fibers are formed by forcing the ether-alcohol solution of pyroxylin through glass capillary tubes, and winding them on frames. As the solution is very viscous it requires a pressure of forty-five atmospheres to discharge it through the capillary openings."

A STUDY OF COMPARATIVE EMBRYOLOGY.

The comparative embryology of the *Cucurbitaceae* (Gourd Family) has been studied by Dr. J. E. Kirkwood, the results of which appear in the *Bulletin of the New York Botanical Garden* (No. 11, 1904). After an instructive historical introduction, the organogeny of representatives of the five tribes (*Fevilleae, Melothrieae, Cucurbiteae, Sicyoideae,* and *Cyclanthereae*) is summarily described, and this is followed by a quite particular examination of the embryo-sac in sixteen genera distributed among the five tribes. Twelve fine plates of 166 figures add much to the value of this portion of the paper. In a closing discussion the author finally concludes that 'in most points the differences between the *Cucurbitaceae,* and other sympetalous families are more striking than the similarities.' The paper closes with a bibli-

ography including 89 titles. It constitutes a valuable addition to our knowledge of the embryology of a family whose place in the system of plants is still in doubt.

A HELPFUL BULLETIN.

THE office of experiment stations of the United States Department of Agriculture has issued a bulletin (No. 2) consisting of an outline of a lecture on 'Potato Diseases and their Treatment,' for the use of farmers' institute lecturers. It was prepared by F. C. Stewart and H. J. Eustace, of the New York Experiment Station. It contains summaries of our knowledge of the most important diseases which affect the potato in the United States. The descriptions are given in nontechnical language, and ought to convince every botanist of the possibility of treating quite difficult subjects in plain English. Following the description of diseases, is an admirable chapter on spraying and other preventive measures. A very useful bibliography is added in an appendix.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE NOBEL PRIZES.

IN a cablegram from Stockholm to the London *Times,* dated December 10, further details are given in regard to the Nobel prizes.

The prize for physics has been awarded to Lord Rayleigh, professor of natural philosophy at the Royal Institute. The chemistry prize is conferred upon Sir William Ramsay, professor of chemistry at University College. M. Pavloff, professor at the Military Academy of Medicine at St. Petersburg, receives the prize for physiology and medicine. The literature prize is divided between M. Mistral, the Provençal poet, and Don Jose Echegaray, the Spanish dramatist. The peace prize has been awarded to the Institute of International Law.

The distribution of the Nobel prizes took place in the great hall of the Academy of Music at Stockholm in the presence of King Oscar. Lord Rayleigh, Professor Ramsay and M. Pavloff received their prizes, together with diplomas and gold medals, in person from his Majesty, while the prizes awarded to M. Mistral and Don Jose Echegaray, who were unable to be present, were handed to the French and Spanish ministers respectively. The sum of money attaching to each prize amounts to 140,858 kroner (about $39,000). The Nobel peace prize will be presented by the Norwegian Storthing at Christiania.

The distribution of the prizes was followed by a banquet at the Grand Hotel. Covers were laid for 190 guests, the company including the Crown Prince, Prince and Princess Charles, Lord and Lady Rayleigh, Sir William and Lady Ramsay and M. and Mme. Pavloff. Count Mörner, speaking in German, proposed the health of M. Pavloff; Professor Petterson, in English, proposed the health of Sir William Ramsay; and Professor Hasselberg, in Latin, that of Lord Rayleigh.

SCIENTIFIC NOTES AND NEWS.

AT the meeting of the American Association for the Advancement of Science held at Philadelphia last week, Professor C. M. Woodward, of Washington University, was elected president for the New Orleans meeting.

AT the recent Philadelphia meeting of the American Society of Naturalists, Professor William James, of Harvard University, was elected president. Professor Chas. B. Davenport, of the Cold Spring Laboratory of Experimental Evolution of the Carnegie Institution, and Professor J. M. Coulter, of the University of Chicago, were elected vice-presidents, and Professor W. E. Castle, of Harvard University, secretary.

PROFESSOR MARY WHITON Calkins of Wellesley College, has been elected president and Mr. Wm. Harper Davis, of Lehigh University, secretary, of the American Psychological Association.

PROFESSOR JOHN DEWEY, of Columbia University, has been elected president of the American Philosophical Association.

PROFESSOR S. W. BURNHAM, astronomer at the Yerkes Observatory, has been awarded the Lalande gold medal of the French Academy of Sciences for his researches in astronomy.

PROFESSOR SVANTE ARRHENIUS has been made head of a laboratory for physical chem-

istry, to be established at Stockholm by the Nobel Institute.

Professor E. E. Barnard, of Yerkes Observatory, will join Professor George E. Hale at the branch of the observatory on Mt. Wilson, Cal. He will take with him the Bruce 10-inch photographic telescope and will spend the rest of the winter and next summer in making photographs of the sun.

M. Vieille has been elected a member of the Paris Academy of Sciences in the Section of Mechanics, and M. Dastre a member in the Section of Medicine and Surgery.

Professor Tanmann, of Göttingen, has received from the German Society of Engineers the sum of 5,000 Marks for experiments on the melting point of alloys.

The superintendent of government laboratories for the Philippines, Dr. Paul C. Freer, formerly professor of chemistry at the University of Michigan, is at present in the United States on a leave of absence.

Mr. George V. Nash and Mr. Norman Taylor returned late in December to the New York Botanical Garden from an exploring tour around the island of Inagua in the Bahamas. The expedition secured a valuable collection of living and preserved plants, including many massive specimens of the few cacti native to the island.

Dr. C. Hart Merriam, chief of the Biological Survey of the Department of Agriculture, lectured at Stanford University on December 15. He has since returned to Washington.

Mr. Charles F. Lummis, of Los Angeles, Cal., lectured before the New York Society of the Archeological Institute of America on December 22, his subject being 'The Primitive Music of the Southwest.'

Lord Rayleigh delivered a lecture at the Academy of Sciences, Stockholm, on December 13, on 'The Density of Gases.'

A window in the cathedral at Norwich in memory of the late William Cadge, an eminent surgeon of the city, was unveiled on December 6, by the president of the Royal College of Surgeons.

Mr. Eugene G. Blackford, of Brooklyn, a fish merchant who made many contributions to ichthyology and did much to promote its study, died on December 28, at the age of sixty-five years.

Mr. Francis H. Nicholas, a newspaper correspondent of New York City, has died in Tibet, where he was making explorations.

We regret also to record the deaths of M. Bernard Renault, assistant in paleontology in the Paris Museum of Natural History, at the age of sixty-eight years; of Dr. I. N. Goroschankin, professor of botany at Moscow at the age of sixty years; of M. André Lefèvre, professor of ethnology at Paris School of Anthropology at the age of seventy years, and of Dr. Karl Koester, professor of pathology at Bonn.

Mr. Robert H. Sayre, president of the Board of Trustees of Lehigh University, has presented the institution with an annex to the Sayre Observatory founded by him in 1860. The building, designed by Professor C. L. Thornburg, contains a zenith telescope, made by Warner and Swasey and presented to the university by Mr. Sayre.

One of the most valuable contributions of scientific material yet made to the New York Botanical Garden has recently been received from Sir William Dyer, director of the Royal Gardens at Kew, England, consisting of many thousand herbarium and museum specimens of lichens, duplicates from the famous lichen herbarium formed by the Rev. W. A. Leighton, of Luciefelde, Shrewsbury, and presented by him to the Royal Gardens in 1882.

The *British Medical Journal* states that at a sitting of the Paris Académie de Medécine held on December 14 the names of the successful candidates for the various prizes offered for medical researches of one kind or another were announced. The Audiffred prize of £960 for the best work on tuberculosis was not awarded, but sums varying from £60 to £20 were given, by way of encouragement, to Dr. Armand Delille, of Paris, for an investigation of the part played by the poisons generated by Koch's bacillus in tuberculous meningitis and tuberculosis of the nerve centers; to Dr. Nattan-Laurier, of Paris, for a research on mammary tuberculosis; to Dr. Pautrier,

of Paris, for one on atypical forms of cutaneous tuberculosis; and to Dr. Lalesque, of Arachon, for a memoir on the sea and consumptives. The Baillarger prize for £80 for researches on mental diseases was awarded to Dr. Paul Sérieux for a series of reports on the treatment of insanity and the organization of asylums. The Adrien-Buisson prize of £420 was awarded to MM. E. Leclainche, professor in the Veterinary School of Toulouse, and H. Vallée, professor in the Veterinary School of Alfort, for researches on symptomatic anthrax and gangrenous septicæmia. The Campbell-Dupierris prize of £92 was awarded to Dr. J. Tissot, of Paris, for an experimental investigation on the exchange of gases in the arterial blood, the ventilation of the lungs, and arterial pressure during chloroform anæsthesia. The Daudet prize of £40 was awarded to Professor Monprofit of Angers for a memoir on tumors; to the same surgeon also fell the Huguier surgical prize of £120 for essays on the surgery of the ovaries and Fallopian tubes, and on salpingitis and ovaritis. The Theodore Herpin (de Genève) prize of £120 was awarded to Drs. P. E. Launois and Pierre Roy, of Paris, for a biological study of giants. The Jacquemier obstetrical prize of £68 was awarded to Dr. Bouchacourt, of Paris, for a series of memoirs on the applications of radiography to midwifery; while Dr. Briquet, of Nancy, gained the Tarnier prize of £120 for a work on tumors of the placenta. The Laborie surgical prize of £120 was awarded to Drs. J. Hennequy and R. Loewy, of Paris, for a monograph on the treatment of fractures of the long bones. The Louis prize of £120 was awarded to Dr. Victor Balthazar, of Paris, for a memoir on the serumtherapy of typhoid fever, and the Saintour prize of £172 to Drs. Fernand Bezançon and Marcel Labbé for a treatise on hæmatology. A considerable number of prizes of smaller value was awarded to various competitors.

We learn from the *British Medical Journal* that Professor Koch expected to start on a new expedition of scientific exploration on December 17. He will first proceed to Dar es Salam in German West Africa for the purpose of completing the researches on cattle plague begun by him in South Africa. These investigations were directed to purely practical objects, while questions of importance from the scientific point of view had to be left untouched. These questions will now in the first instance engage Professor Koch's attention, but he will also study other tropical diseases affecting animals and man. As occasion arises he will go to other places suitable for purposes of research. Professor Koch estimates that he will be away six months. On December 11 a dinner was given by a committee formed to celebrate the completion of his sixtieth year.

The report of the Meteorological Council for the year ending March 31, 1904, to the president and council of the Royal Society has been issued as a Blue-book. According to an abstract in the London *Times* it is stated at the outset that a meeting of the International Meteorological Committee was held at Southport during the session of the British Association at that place. Among the subjects then raised was the very important question of the units adopted in different countries for meteorological measurements. In the United Kingdom, its colonies and dependencies, and in the United States the inch and the Fahrenheit degree have always been used for the measurement of pressure and temperature, whereas in the rest of the world the millimeter and the centigrade degree have been adopted. The council state that if they can obtain a satisfactory consensus of opinion as to the method of measurement which will probably commend itself to the approval of all civilized countries, they are prepared to give effect to proposals for the adoption of that method in this country without delay. After discussing other matters dealt with by the international committee, such as the report of the sub-committee on cloud observations and the relation between solar and terrestrial changes, the council proceed to state that the office has been in communication with the Deutsche-Seewarte and the Meteorological Institute of the Netherlands with regard to the 7 A.M. service of telegraphic reports. In order to obtain reports at that hour from the east coast of England, a special sta-

tion was established at Skegness. Reports have also been obtained from Portland Bill, and Malin Head has taken the place of Blacksod Point. A station was still required, however, on the south coast of Ireland to complete the requirements of the two continental offices. In other respects the arrangements for weather telegrams between this country and the continent of Europe, the Azores and the United States remained the same as in the preceding year. The council regret that the practical extension of wireless telegraphy has not enabled them to increase the area of observation to the westward by information obtained from Atlantic liners by that means.

UNIVERSITY AND EDUCATIONAL NEWS.

Lord Rayleigh proposes to present to Cambridge University the value of the Nobel prize for physics which has just been awarded to him.

The secretary of the University College of North Wales has announced that the recent bequest to the college by the late Dr. Isaac Roberts, the astronomer, is expected to realize £15,000.

The University of Edinburgh has received a gift of £25,000 from Sir Donald Currie for the establishment of lectureships. £5,000 may, however, be used for the purchase of a site for new laboratories. The university has also received £15,000 from other sources.

In accordance with the will of George Smith, '53, of St. Louis, filed in March, 1902, the treasurer of Harvard University has received in cash and securities a payment of $257,550.66. When this fund reaches $450,000 by accumulation, three new dormitories are to be erected. They will be named the James Smith Hall, the Persis Smith Hall, and the George Smith Hall.

It is reported that general plans for the new Yale library to be built from the Ross legacy of $250,000 are definitely settled. The Chittendon wing will be preserved, and the first part of the new library will probably be built between that wing and the present old university library, which will thus be preserved for some years. The new structure will probably use up the whole legacy of $250,000, and will supply all university library needs for twenty-five years to come.

Hollis Hall, the oldest dormitory of Harvard University in use, was damaged by fire to the extent of $5,000 on December 29.

The Columbia University Council has authorized the degree of graduate in pharmacy to be conferred, as in the past, by the New York College of Pharmacy, but has provided for the establishment of a course of higher grade leading to the degree of pharmaceutical chemist.

A school of veterinary medicine and surgery was opened at the University of Liverpool on December 13.

The Association of American Universities will meet at Johns Hopkins University, in Baltimore, on January 12, 13 and 14. The following are the delegates: California, Professor B. I. Wheeler, Professor Irving Stringham, Professor Leuschner; Catholic, Dr. E. A. Pace, Dr. M. F. Egan; Chicago, President W. R. Harper, Professor A. W. Small; Clark, President G. S. Hall; Columbia, Professor Monroe Smith, Professor W. H. Carpenter, Professor Henry M. Howe, Professor E. D. Perry, Mr. F. P. Keppel; Cornell, Dean Thomas F. Crane; Harvard, President C. W. Eliot, Dean J. B. Ames, Professor T. N. Carver; Johns Hopkins, President Remsen, Professor Gildersleeve, Professor Welch; Leland Stanford, Jr., Professor A. H. Suzzallo, Professor E. P. Cubberley; Michigan, Professor A. C. McLaughlin; Pennsylvania, Dean J. H. Penniman, Professor J. C. Rolfe, Dean Clarence G. Childs; Princeton, Professor A. F. West, Professor W. M. Daniels, Professor H. B. Pine; Virginia, Dean J. M. Page, President E. A. Alderman; Wisconsin, President Charles R. van Hise; Yale, President A. T. Hadley.

John Robert Sim, assistant professor of mathematics in the College of the City of New York, has been made head of the department of pure mathematics.

Dr. Oskar Brefeld, professor of botany at Breslau, has retired from active service.